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Queen's University
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Prospects for Minerals in the 90s

Proceedings No. 21

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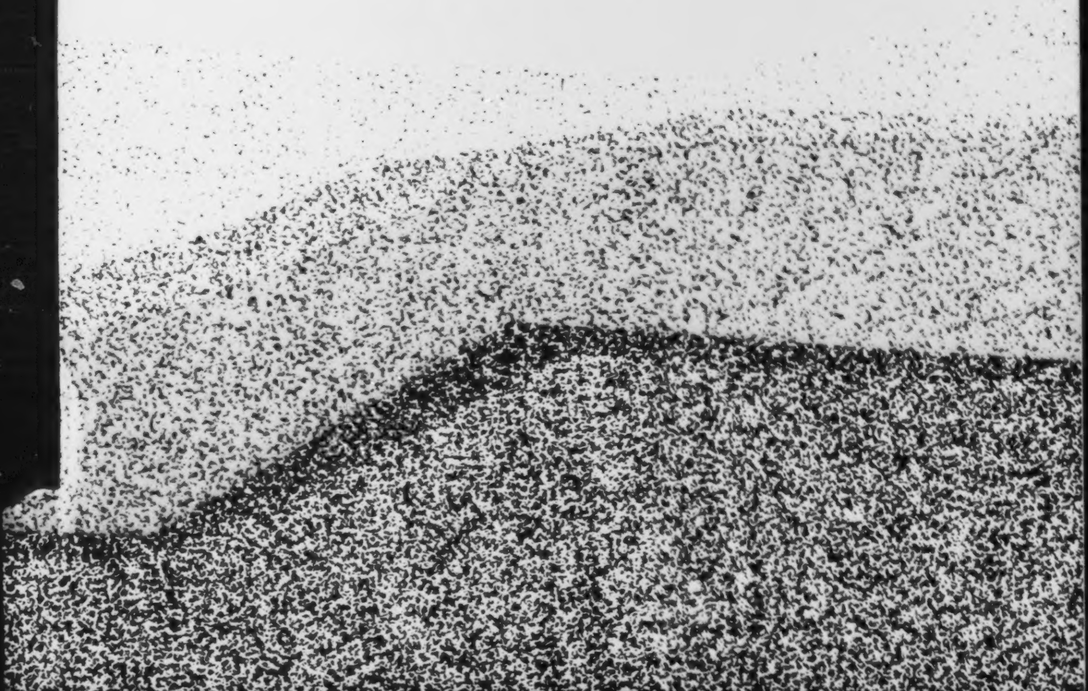

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PROSPECTS FOR MINERALS IN THE 90s

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Edited by

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FOREWORD

This volume contains the proceedings of the 18th CRS Policy Discussion Seminar. The CRS seminar series brings together individuals from industry, governments, labour, universities, and other organizations to share their knowledge and views on selected issues in mineral policy.

The seminar was held at the Donald Gordon Centre for Continuing Education in Kingston on October 14-16, 1987. The program was arranged by Peter Richardson of Queen's University School of Business, in consultation with CRS. The proceedings volume was edited by Peter Richardson and Renka Gesing and produced by Dorothy Smith.

The Centre is grateful for the contributions of the speakers and participants, both during the seminar and in the preparation of the proceedings. Views expressed are those of individual participants, and do not necessarily represent the views of the Centre or its sponsors.

Margot J. Wojciechowski
Centre for Resource Studies

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PROSPECTS FOR MINERALS IN THE 90s

Peter R. Richardson

During the 1980s, the Canadian mineral industry has faced challenges unprecedented in modern times. Changing patterns of demand arising from maturing markets and new materials, combined with over-supply and fierce price competition, have created a new business environment. The only consistently bright spot has been the lustre of gold and some other precious metals.

Generally, the industry has responded well to these challenges. Corporations are leaner and more profit oriented. They have met the task of improving relations with a variety of stakeholders including work forces, unions and governments. Renewed interest in product and process innovation is starting to pay off in the introduction of lower-cost production techniques and the development of new markets.

These developments do not necessarily mean that a decade of prosperity and problem-free operations lie ahead. As always, there will be new challenges, and some of the old issues that have troubled the industry still must be resolved. The identification of these challenges could provide both government and private sector executive with the outline of a strategic action agenda for the new decade, or at least a set of issues which they should track and monitor. In addition, CRS hopes to develop new research directions and organize future policy seminars which focus on these areas.

In this seminar we asked a number of people with a wide knowledge of the industry to present their views, forming the basis for subsequent discussion by seminar participants. Several talks provided a broad overview of the issues from the different perspectives of the federal government and the industry, both domestic and foreign. Other papers focused on specific challenges:

- future demand and supply patterns for major minerals;
- trade and access to markets;
- new competition from engineered materials;
- safety and occupational health.

These four issues, together with others which were identified in the seminar are likely to play a major role in shaping the fortunes of the industry in the next decade. We hope that these seminar proceedings will provoke an examination of policies and strategies needed for the mineral industry in Canada to grow and prosper.

FUTURE CHALLENGES FACING THE CANADIAN MINERALS INDUSTRY: A PRIVATE SECTOR VIEW

Norman B. Keevil Jr.

Forecasting the future is usually a mug's game, and yet one of the challenges for business, and the mining industry is no exception, is to try to do just that. We must try to size up the future in order to decide what it is we should be doing today. And there may be several futures - a bright one, a dull one, or a terrible one. Rather than count on only one of these, when all have a finite probability of occurring, perhaps the essence of preparedness is to be ready for each through a combination of offensive and defensive positioning.

Most of us, however, have our perception of the future coloured by the present or immediate past. When the Club of Rome, a group of eminent futurists, forecast that the world would run out of raw materials, OPEC seemed to support it in 1973, and in 1974 the price of copper soared to a level it has not seen since - in constant or any other kind of dollars. They were intelligent men, but they proved wrong in their timeframe. Even though some day we may run out of the odd thing such as petroleum, this kind of reasoning contributed to the glut we have of many materials today.

By 1979 and 1980, with inflation strong, raw materials in the ground were again in vogue - the great inflation hedge - and companies were incurring large amounts of debt to expand production, improve facilities, and at times just to buy other companies. Dome Petroleum is only the biggest example of something many of us indulged in. Few foresaw the severity of the 1981 recession, although some did begin to shy away from excessive debt as interest rates began to climb towards 20 percent. Perceptions of the future are now influenced by memories of that recession, the effects of which are still being felt in our industry.

There is much talk of "structural changes", and some of this has certainly occurred. If, however, structural change is intended to imply a permanent change, then the term may be overused. Some of what passes for structural change may be just a temporary response to a deep economic cycle. Given that there is a spectrum of possible futures - ranging from terrible to dull to bright - and the fact that we have a vivid memory of the recession, the challenge we have set in our own company is a twin one, a combination of defense and offence.

We intend to, on the one hand, get costs down to a level that will see us survive, hopefully with some profit, the worst of times, and on the other hand to come up with new, low-cost orebodies that can be developed into strong new producers. In other words, in the game of economic hockey, we intend to survive if the black number 99 has the puck, but to be positioned to do well on the upside if the white 99 happens to prevail.

When a group led by Teck Corporation bought control of Cominco a year ago, we had just come through a fairly major restructuring program, primarily through the divestment of non-core assets, to decrease our own debt. Interest costs had been the main factor behind our first loss ever in 1982. Our restructuring, however, had reduced debt and, with new development projects, we had turned Teck back into steadily-increasing profits, even though most metal prices were generally still around their recession lows.

When Cominco was offered to us, its debt load was about $1 billion, and it had just incurred a $71 million loss - an unlikely acquisition candidate for a company which had just spent several years getting its own balance sheet in order, particularly when the cost of the Canadian Pacific block was about $500 million.

On the offence side, however, Cominco had some excellent assets. These included a modern zinc smelter, at Trail, the largest in the world, as well as three excellent new mines on the drawing boards: Valley Copper in Canada, the Hellyer zinc project in Australia, and the exceptional Red Dog zinc project in Alaska. The question was not whether to pursue the offer, but whether we could develop a good defence as well. This was achieved by bringing in two partners, MIM of Australia and Metallgesellschaft of Germany, for 25 percent each of the acquisition cost.

In combination with other steps, this reduced the cost to the point where we could complete the purchase for $100 million, without incurring a cent of borrowed money, rather than the $500 million of debt that seemed required at first blush. There are, therefore, creative ways of answering the challenge of positioning for a bright future while defending against a bleary one.

Improving the balance sheets has been, and in many cases continues to be, a challenge for many in the Canadian mining industry. Fortunately, since the economic climate has been reasonably good in the last couple of years, most companies have shown considerable improvement. But some need to do more, and one hopes the climate will continue to permit this.

Cominco is a good example of substantial improvement in a short time. Its debt peaked at $1.05 billion at the end of 1985. This has now been reduced by $750 million to $300 million, a figure which will continue to decrease until construction costs at its new Red Dog Mine start to increase the debt. This major improvement, which put the company back in the black, illustrates that the challenge of putting a balance sheet in shape can be met. Although the control of the balance sheet should not be stressed over the control of other costs, interest costs were, and in some cases still are, one of the most serious impediments in our industry.

Since 1980, the mineral industry has made substantial strides in reducing operating costs and improving productivity. We did it because we had to, and will have to continue to work hard in this area to be competitive. Most miners in the world experienced the same recession we did, and have responded by trying to cut costs. If we do not follow suit and continue to at least match the gains of the competition, we risk being left behind. Our competitors are not asleep.

In the USA for example, the remaining copper producers have dramatically reduced their average production costs from what they were before the recession by installing new, low-cost lines using, as is the case at Phelps Dodge and other mines, solvent extraction and electrowinning.

In addition to individual company efforts, the Mining Association of Canada has formed MITEC, an organization dedicated to sponsoring centres of excellence at Canadian universities in the areas of advanced mining and processing technology.

On the subject of cost cutting, permanent productivity gains represent the positive side of the coin. The other unfortunate side appears when economic conditions force us to rob Peter to pay Paul, to take steps to ensure current survival which in turn will lose future sources of ore. If we increase our cutoff grades to stay alive, the lean ore left behind, particularly in underground mines, may be lost forever. If, in an open pit mine, we defer waste removal to stay alive for say five years, then, unless prices of the minerals mined rise, we may never be able to justify the capital to move that waste at the end of the period and the mine could be lost. Thus, another of our challenges is to try our best to avoid losing reserves to which we may be unable to return.

This brings up yet another a major challenge, one which is not discussed nearly enough - our depleting ore reserve base. The challenge is to recognize that this is a problem, and then to do what we can to ensure that the ore reserve base is replaced. For example, let us consider the last annual report of one of our better known, major, old-line Canadian mining companies, which I'll name Company X. This company has about ten metal mines. Three have a good reserve life of ten years or more, one of six years, and six of them had a reserve life of only four years or less - and one of these has since closed.

The statistic that 60 percent of Company X's mines had a reserve life of four years or less is very disturbing, particularly to the extent that it is indicative of a potential industry-wide problem. As a person from the exploration side of the industry, I have been working for a long time to develop new mines to replace those that are running down. And the older I get, the more likely it is that the old ones running down are the once new ones I helped bring on. The slow rate at which new mines are being discovered and developed is a real problem.

One of the legacies of the recession was that the easiest discretionary cost to cut when things are bad is exploration, even though we all should know exploration is the life-blood of our industry. One of our challenges is to quickly bring this exploration back up to its rightful level. The significant lead time between exploration, discovery, and a producing mine is longer than the up-to-four-years' reserves of 60 percent of the mines of Company X, which may not be too far off the industry profile.

Gold has been the exception. The yellow metal has been in vogue and has won the almost exclusive attention of junior company exploration dollars. There have been a number of successes and even a major one at Hemlo. Base metal exploration, however, has suffered. We must recognize that we have the infrastructure of an established smelting and refining industry in this country, but that we need to generate the discoveries necessary to maintain it.

Cominco is a success story in this respect. Its Pine Point mine has run out of ore and Kimberley is witnessing a slow decline, but the company will be able, for the next 50 years, to replace these as feed for its Trail smelter thanks to its new Red Dog mine in Alaska. But not all of our smelters and refineries can point to assured feed five and ten years down the road, and some are already experiencing shortfalls. We have always known mines are a depleting resource; that is why historically our taxation system permitted a depletion allowance. Now that we have come through a tough period of reserve losses and insufficient base metal exploration, depletion looms larger than ever.

Some time ago, the industry accepted the change from automatic depletion allowance to earned depletion. There may be some justice in withholding depletion allowance from the company that simply mines out an orebody and runs. In addition, since most of us were conscious of the need to explore, we did not mind spending the dollars to earn the depletion allowance. Unfortunately, the allowance was recently identified as a loophole, and lost out in so-called "tax reform". Its abolition, which will severely hurt flow-through share financing, will reduce exploration just at the time when it is needed most.

We missed stressing the real point, that depletion of our reserve base is a continuing challenge requiring continued successful exploration, perhaps now more than ever. We failed to emphasize that depletion allowance is not some kind of tax loophole, but a recognition of a unique characteristic of our industry. It may have been a mistake, for example, merely to point out the benefits of flow-through financing in creating exploration jobs in Northern Quebec. Thus, one of our main challenges is to replace a too-rapidly declining reserve base, with the reinstating of earned depletion as a subsidiary challenge. This will in turn allow flow-through share financing to assist in the main challenge.

Even though mining differs from most industries in that its resource is finite and depleting, it still shares the need to be competitive. The recipe for all industries is simple: to produce a product people want to buy, at a price they are willing to pay, and at the same time turn a profit. If we cannot turn a profit, we lose, and eventually we are gone. If we cannot produce at a price they are willing to pay, given that they can get it elsewhere more cheaply, then we lose and are gone. This is the challenge of productivity in a world marketplace.

The most interesting part of the recipe is "a product people want to buy". One of our challenges is to do a better job of marketing our products, as opposed to simply selling. If we can convince people to use more zinc, for example, then we can sell more. The Europeans, and particularly the Germans, have done a good job in marketing zinc - not just the metal itself but also its corrosion resistance. Architectural awards are given for the creative use of the metal, and zinc is now used on buildings as protective cladding against Europe's acid atmosphere. The aluminum producers have been good at this for years, and Inco, who recognized it had more metal than could be absorbed by the existing market, was a leader in developing uses for nickel decades ago. Inco created the need for nickel. One of our challenges in the metals or mining industries is to become more creative in marketing our products and in creating new markets.

There is, therefore, a twin challenge: exploration to replace a declining reserve base, so that we have a product to start with, and marketing to sell the products we hope to produce. And marketing is not simply dumping product at the LME price; it is creating demand.

Overcapacity is another problem with which we are not dealing swiftly enough. For example, there are in Saskatchewan one or two too-many potash mines. As a result, everyone suffers low prices because of excess production and inventory. Zinc refining is in a similar situation. Europe has 17 refineries; all are losing money and yet all are scrambling to top up the last tonne of concentrate to cut their losses. The solution is simple. Shut down excess capacity; cut out the 10-20 percent at the high cost end so that the 80-90 percent can make a reasonable return. Life, unfortunately is not that simple. Apart from social considerations, the most uneconomic producers find ways to hang in, prices stay low, and all suffer.

The zinc refining businesses in the European Economic Community (EEC) twice have come close to resolving this problem by attempting to band together to pay the most uneconomic producer to shut down for the good of an industry - a smart solution. Unfortunately, social policy gets in the way; what would Belgium be, without its own zinc refinery? Anti-cartel laws also tend to get in the way.

The last big challenge to mention is protectionism, and this, of course, means the United States. The Americans manage to eat their cake and have it too. If we sell them potash too cheaply, one branch of the U.S. government retaliates. If we get together as a purported cartel and raise the price, then another branch jumps on us. If we pass laws to control acid rain and then offer assistance to those affected, they call it a subsidy! If we encourage regional development (while their states are doing the same through low-cost financing such as municipal development bonds) they call our assistance a subsidy.

The USA, however, is this country's largest market. The Canadian government's attempt to negotiate a free-trade pact is commendable even though we may not have immediately achieved the perfect pact. Prime Minister Mulroney deserves a lot of credit for getting us on the road to a resolution of our trade frictions with the USA.

We do live in a global world, and nowhere more so than in mining. We compete, for example, with the Australians in coal, the Chileans in copper, and the Europeans in zinc. In a global market we must have a global perspective, and that is why Teck Corporation has been developing a global network. With our Australian and German connections we have the basis of a communications network, based not on branch offices but on entrepreneurial associates in each area. If we can expand this to Japan and other areas as well, so much the better. Our industry must compete in this global environment in whichever way seems best for each individual company.

There are other issues and challenges. The value of the Canadian dollar is a crucial one on the economic side. If it was allowed to approach parity with the U.S. dollar, we could say good-bye to most of our minerals industry. Competition from new materials is another challenge. On the social side there are, among others, questions of environment, safety, the provision of infrastructure, and fly-in camps as an alternative to traditional mining communities.

Finally, when considering futuristic challenges and strategies, remember that few of those who have succeeded in this business have done so by having crystal balls.

EMERGING TRENDS IN WORLD MINERAL COMPETITION: A VIEW FROM DOWN UNDER

John Macleod

This discussion will range over a wide number of issues facing the minerals industry in the next decade. A deliberate decision was taken to cover a wide spectrum of issues, without any ranking of priorities, rather than concentrate on a few.

The major Australian companies are accustomed to focusing on long-term emerging issues; relatively few short-term options are available in this capital-intensive business. The views presented will reflect the rather different orientation of the Australian industry. We do not have a major market sitting on our border, and we are a long way from European markets and tend to be less competitive in Atlantic markets. But we are international in outlook and fiercely competitive. I trust that many of the issues raised are of importance to the Canadian industry.

Long-Term Geographical Shifts in World Industry

Looking back over the past 30 or 40 years of the minerals industry throughout the world - and when I use the term minerals industry, I mean exploration, mining, refining and smelting, but exclude oil and gas - a couple of observations stand out. The first is that the industry has been forced to change to face new market and political conditions, and in doing so, its profit record has been generally poor.

The second observation is excess capacity. Why does the industry consistently get itself into a position of worldwide excess capacity? For obvious reasons: Australians sometimes liken the industry to a flock of sheep - one leads and all the rest follow on.

The world industry is facing long-term geographical shifts, as spelt out in "Outlook for Mineral Commodities", a paper by Sir Roderick Carnegie.[1] This essay points to two important trends in the industry. First of all, there has been a long-term shift, which we think will continue throughout the 1990s into the 2000s, in both the mining and the refining and smelting industry from the developed to the developing countries. Why? In the developed countries, the best orebodies are being mined out, costs are higher, exchange rates often price companies out of the business, and environmental issues are of increasing concern. Generally, these developed countries are looking for higher value-added businesses rather than the basic mining/refining industries. Some developed countries have lost their colonies and thus a captive source of raw material. Increasing levels of subsidies for industries such as coal and steel have put strains on budgetary resources in many countries.

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[1] Group of Thirty, New York, March 1986.

The second point noted in the essay is that the industry in developing countries is run by state-owned mining enterprises, and it behooves us all to think hard about how these behave, compared to privately-owned enterprises.

Developing Countries - Implications for the Industry

This latter point raises several implications. First of all, what motivates state-owned mining enterprises? Will they put high-risk money back into exploration, or even more importantly, into research and development? Do they have a backup in terms of academic and other scientific research to support the activities, as has industry in developed countries? In countries such as Chile or Zambia, the answers to these questions are all "no". In such countries, state-owned mining enterprises exist to collect rent for the government. Formed as a part of the anti-colonization process, they exist largely for political, not economic reasons. The government has no vested interest in exploration or research, and certainly not in development of costly new methods, products, etc.

A commitment of developing countries to the markets is another serious consideration. In many cases, the developing countries do the mining, but downstream activities, including basic metal products, have tended to remain in the developed countries. Thus, raw material producers frequently do not adequately address the question of markets for the end product and the need to develop and expand these markets. Aluminum, where an integrated chain from bauxite to canning sheet developed on the basis of a strong commitment to the development of markets, used to be an exception. Contrast this situation with the copper industry, and one reason why excess capacity arises becomes clear. Dumping product on terminal markets is quite different from a commitment to expand usage of metal. The key question is to what extent the mining section of the industry accepts its long-term responsibility to increase the consumption of metal.

Another point for the 1990s is whether developing countries will want to push into the processing side of the business, to send, for example, more slab and less iron ore into the world market. If they decide to do so, some of the larger developing countries will have major competitive advantages.

The credit standing of the developing countries is an added complication. Although no one is happy to see developing countries saddled with a nearly strangling level of debt, these countries must face the facts: a long time will pass before they shake off their debt constraints. This has implications for developed countries. Two important countries for Australia, for example, are Papua New Guinea and Indonesia. Because of their modest but critical foreign debts, the financing of our major new mines in those countries requires skill and credit-worthy partners. A new factor in this business is discounted foreign debt or, in the jargon of the trade, an equity swap business: very important, because you have a major competitive advantage if you can buy the domestic captial requirement at 60 or 50 cents to the dollar.

Recycling

Another issue for the 1990s, and an obvious one, is recycling. The developed countries are increasingly poor in ore and rich in scrap. This issue, which the industry had only barely begun to foresee in the 1970s and 1980s, must now get more serious attention. Recycling is but one of a range of social issues which the industry can no longer ignore; it cannot leave it to the "do-gooders" in the community to set the pace and resolve social or environmental issues. It cannot allow such do-gooders to set the public debate. To this end, industry needs strong, very strong, leadership.

Subsidies and Protectionism

The main debate around the world in terms of subsidies and protectionism has been in agriculture or in the manufacturing industry, rarely in the mining, refining and smelting sector. Expect, however, to see Australia put this issue on the agenda of the current round of the General Agreement on Tariffs and Trade (GATT).

Subsidization in developed countries of our industry is even more blatant than in the agricultural sector. The consumer, unfortunately, is not made aware of the costs of what has been more politely and accurately described in some countries as a regional social welfare program. European Economic Community (EEC) protection for coal mining and steel making are two examples. The industry must come to grips with this issue. Its resolution could speed the geographical changes in the location of the industry. Japan does not prop up or support losers in industry. As seen with the Japanese aluminum and coal mining industries, the country tends to cut losers faster than other developed countries. Why buy coal at $100 per tonne when some crazy fool like Australia will supply it to you at $30 or $40 per tonne? What this teaches us, a lesson the rest of the developed world has not understood, is that, as Japan gets out of these industries, it becomes more competitive in relation to those who continue to prop up the losers.

Australia will be using this very important lesson in the GATT discussions, where we hope to get Canada's support. The industry needs to open up a second front within the GATT round which adresses continued subsidization and protection and voluntary restraints. Let's put it on the table; let's negotiate.

World Government Issues: Leadership and Communication

Where does the leadership from the industry worldwide come from as it dies in the developed countries - USA and Europe, and now, more importantly, Japan? The developing countries? Can we expect the CVRDs and the Codelcos to provide the leadership? Can we look to Canada or Australia? So far, Canadians have been quiet, while Australians have not shown any particular desire to take on the mantle.

How does the industry worldwide communicate? Communication so far, at least in Australia's case, has been hindered by anti-trust laws. Study groups, such as the lead-zinc, nickel, or tungsten study groups, are one approach to this problem, but are they the most useful forum? Participants are government representatives, who often do not have first-hand knowledge of the issues. In the case of Australia, the study groups are represented by the federal government, while it is the state governments that know what the companies are doing and actually own all mineral resources.

Asia

Australia does not look at the world through European or North American eyes, but through Asian eyes. In this context, I want to stress three important aspects: Japan, the Little Tigers (Taiwan and Korea), and the People's Republic of China.

Japan

Looking back over the 1960s and 1970s, it becomes clear that Japan peaked as a major force in the industry - as a producer, that is; not as a consumer. As the world's second largest economy, Japan has come to dominate world trade in minerals, a success built by a disciplined society. The Japanese success in the mineral processing industries is largely based on deep-water ports, high quality materials, and large bulk volume. The Japanese steel industry bears no resemblance to the North American or European steel industries. Europe and North America have suffered the consequences of not accepting the technological challenge thrown down by the Japanese.

As buyers of raw materials, the Japanese have proved to be masters. They have encouraged new capacity in excess of demand, forcing suppliers to cut costs. The result is that they appropriate all productivity gains for themselves in the form of lower costs. This is where the expression so popular in Australia comes from: "Beware of Japanese carrying a forecast".

Another characteristic of industry in Japan is a reluctance to offer yen sales contracts. Much to our annoyance - we have spent nearly 20 years trying without success - the Japanese have consistently and persistently refused to sign sales contracts in yen. Some contracts were written in Australian dollars, just at a time when they were better left in U.S. dollars! Learning to do business in an environment so different from our own takes a long, long time.

A look ahead to Japan in the 1990s is presented in the Report of the Australia Japan Business Forum Economic Survey Mission to Japan.[2] The Australian government asked five business economists, of whom I was one, to go to Japan in 1987 and take a look at the medium-term prospects for that economy, and their potential impact. This document explains what we discovered. We can expect major changes from Japan in the 1990s, and Japan will not initiate these changes voluntarily; on the contrary, it will be forced to do so. Japan faces the choice of opening up its domestic markets, or suffering currency and protectionism adjustments. One critical aspect is: where does its highly successful manufacturing industry relocate? The subsequent implications for the mining industry need to be considered very carefully.

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[2] Australia Japan Business Forum, Canberra, Australia, June 1987.

The Little Tigers

Closely following the example set by Japan are the Little Tigers, especially Taiwan and Korea. In these countries, to the embarrassment of the rest of the world, we see a developing country model based, not on hand-outs or preferences, but on domestic demand. Those who think of Japan as an export wonder are mistaken. The Japanese model is based on domestic demand; exports are a very small portion of the country's economy. The Tigers, having learned that a fast-growing home market is the basis for success, are now experiencing some of the same market pressures faced by Japan. The United States, with its threats of dire consequences, is a powerful force for change in these countries.

It is important to understand which way these Tigers are going to jump; they will have to change ground very quickly. Korea, a country which in 1980 made no cars at all, is forecasting exports of 3 million automobiles per year in 1990. And where will the metal for those cars come from? Those in the zinc business will know about the rapid growth of the Korean industry and markets. The direction of these economies is a major issue for the 1990s.

The People's Republic of China

CRA has great expectations for the Chinese economy, which has been maintaining sound growth over the past decade. The old joke used to be that the miner dreamt of the day everyone living in China would have a bicycle with a galvanized steel frame, copper handlebars, and aluminum wheels. In Australia, we no longer dream about that; we dream of the day when the Chinese will hold gold bars and wear Argyle diamonds. China can no longer be thought of in terms of bicycles.

The Chinese represent a whole range of issues as consumers; they are not only importers, but also exporters.

This is very important because China may be on the verge of becoming a member of GATT. If this happens, then the way Chinese goods are priced must become more transparent. As owners, investors, or partners, the Chinese are proving very interesting. China is a country with a need for domestic investment, yet it is also investing outside the country. And the Chinese are proving to be smart investors. The iron ore mine in Channar in Western Australia offers one example. In this case they are buying a 40-percent interest in the Channar mine, and all the investment is allotted to the mine, with the infrastructure utilizing Hamersley's existing facilities. The mine will produce about 10 million tonnes per year of very high grade iron ore which is destined to go straight to Chinese steel plants.

China has learned from the Japanese the critical requirements for a successful steel industry: use high grade materials, in large scale facilities. The next step is to build a port in which they can receive large vessels. Australia, in the meantime, is learning to understand the needs of this important partner.

Volatility in Exchange Rates, Interest Rates, and Metal Prices

The industry has been forced to learn to live with extreme volatility for decades. That experience was usually confined to metal prices on a day-by-day basis, with sales volumes also volatile, but over a longer period. Now with the deregulation of the world financial markets, the industry is facing an almost bewildering additional degree of volatility in exchange and interest rates.

Much of the competitive analysis for a mine or smelter has been based on cost curve analyses. All this painstaking work can be turned on its head in a matter of days by the foreign exchange markets.

The volatility cannot be avoided, but much debate rages over the contrast between, for example, annual iron ore contracts and LME-based pricing of contracts. The financial entrepreneurs have responded to the volatility with a range of sophisticated products which, at a cost, can limit the risk. But all this requires great skill and attention, quite different from the production orientation of management in the minerals industry.

Regarding exchange rates, for example, the gyrations of the Australian dollar over recent years have added to the minerals industry policy debates and frequently clouded the issues. It will be clear that the exchange rate in a country such as Chile is more likely to be quickly influenced by movements in metal prices or volumes, whereas in Australia (where the industry is probably at the most 10 percent of the GNP) the export connection is much less direct. We have had to explain to many, for example, that although the Australian dollar has been devalued against the American, many other important mineral producers (competitors) have devalued more than Australia.

Clearly, the exchange rate policy of countries such as Chile and Papua New Guinea is a new factor in investment decisions.

Technology in End Use of Metal

The "thinner, lighter, stronger" syndrome, a dominant factor in metal consumption for many years, is not nearing completion. This seems to indicate that consumption growth will come either from new markets such as Taiwan and Korea, or through new uses for metal in existing markets. Consumption must be stimulated but who has the responsibility to stimulate it? In the past, the industry, with the exception of aluminum and nickel, has been leaving this responsibility to somebody else: the fabricators down the line; or an auto manufacturer; or others who have no real reason for pushing the consumption of copper, or any of the other metals.

The issue of the 1990s, the 2000s, and every year thereafter, is consumption. The industry must decide whether it has a more direct role in encouraging an increase in metal consumption, or whether it will leave the task to others, be they producers of competitor products or end products.

Supply

Coupled with the problem of decreasing consumption is continual oversupply. There is no reason to think that this sheep-like behaviour of the industry, consistently building four new copper or bauxite mines when only one is needed, will change. Have we learned anything as an industry? It seems that the answer is no.

The initial decision to mine is normally driven by the geologists. If they discover a beautiful new orebody, their attempt to rush it into production will be a powerful force; after all, it might be the best copper mine in the world. But the geologists form only one of the parties wanting to bring a new property into production. Governments at all levels, for example, are usually keen, especially if an election is in the offing. And so the number of parties - owners, suppliers, customers, tax agents, etc - urging the go-ahead is very large. The nature of people who run mining companies suggests they are not going to change, and we can thus expect further excess capacity.

The other party in the question of excess capacity is the banker, who also never seems to learn. Consider gold, for example. So-called "creative financing" is even now rushing around the world financing anything that resembles a new gold mine, thereby contributing to eventual problems of excess supply.

Australia

Poor Profitability

The industry in Australia is in a state of shock; survival is the name of the game. The first reaction of a mining company to a drop in prices is to increase production, the rationale being that with each extra tonne mined, the company's unit cost will fall and it will be thus more competitive. The operator does not want to listen to explanations that everybody around the world is doing likewise.

Profits in the Australian industry have been poor. The ten years up to 1980, where effective after-tax returns were between 12 and 14 percent for funds employed in mining and between 9 and 10 percent for refining and smelting, were reasonable. Seven terrible years followed. Mining has returned between 5 and 6 percent after tax, and refining and smelting between 1 and 2, at a time when the government bond rate was over 15 percent. Clearly, this environment will not be able to attract new investment.

Gold Fever

Australia divides its mineral industry into two parts: gold and the rest. Gold has caught hold of the country, and the fever is unbelievable. This gold mania is built around a tax-free status: gold companies pay neither a corporate income tax nor a state royalty tax. Unfortunately, the discipline of supply and demand has been forgotten in the rush to bring new properties into production. Geologists are asking what else they can find for their companies to sell.

Australia had once been the largest gold producer in the world, and the country seems to be aiming for that position again. So are many other countries. So far, the new gold has been mined mostly by small enterprises, i.e. a wheelbarrow and five men, and occasionally a bulldozer plus a large sheet of plastic. Once the geologists have had some time, however, bigger mines will come forward in Australia, Indonesia, and Papua New Guinea.

But who is going to buy all the gold? So far, much gold has been going to the Asians and to the fad for gold coins. Off-shore Chinese have always liked gold and always will (wealthy individuals hold as much as 25 tonnes); the Japanese like gold and hold large quantities.

Productivity and Realistic Expectations

Putting gold aside, the name of the game for the rest of the mining industry is productivity, an area of major potential for striking gains. Australia is on the threshold of the ability to cut costs significantly, and the bottom is not in sight, despite considerable progress to date. We have learned, for example, that we must seriously study the question of how people work together productively. The Australian mining industry is characterised by wages well above the national average, but a strike level of twice the national average! The coal-mining industry is leading the way, through some very painful levels of readjustment. Restrictive trade practices are slowly being dismantled and the capital equipment is being worked more productively.

As disclosed in the annual Minerals Industry Survey,[3] the Australian Mining Industry Council (AMIC) has spent much time analyzing the productivity of the industry. Some years ago, the fact that the Australian minerals industry needed to develop a more realistic national set of expectations was recognized as a problem. Up to now, mining, refining and smelting was thought to be an easy way to make big money. Such "get-rich-quick" expectations created an environment where everybody - governments at all three levels, trade unions, employees, and even management - thought they could exploit an industry which appeared so profitable.

We have been setting about changing those expectations, painfully and slowly. The AMIC annual survey, which simply adds up the balance sheets and income statements of the main companies, is now the accepted source of conventional wisdom on the financial status of the mineral industry in Australia. As an industry, we have been able to get politicians, bureaucrats, journalists, and our own senior staff to understand that profits have really been poor. Many are finally realizing they cannot continue to exploit the industry and are looking instead to help the industry as it meets the pressure from competitors to lower costs.

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[3] Australian Mining Industry Council, Canberra, ACT, Annual.

One example of progress is in an area many thought was untouchable: coastal shipping, waterfronts and railroads. Since CRA runs one of the world's largest freight railroads with Australian equipment, design, technology, computers, we know the tonne/mile costs for freighting raw materials. Thus, when a state-owned railroad charged eight times the freight rate, we were able to analyze their costs. They ran a train with four crews, where we used one. In the early days, locomotives had to take on water, and every time they stopped they changed the crew. These practices hark back to an era when the industry was wealthy enough and had rich enough orebodies to support these luxuries. Today it does not.

The lower limit of the industry's ability to cut costs in other areas is not yet in sight. There are many other examples of far-reaching change the Australian industry. There is a major review of corporate taxation underway, especially depreciation schedules, which could significantly change the competitive structure of this capital-intensive industry. But the top of the pile in terms of industry issues for cost cutting in the 1990s is human resources management. Second is technology: more money, much more money, is being devoted to research and development in all phases of the industry - exploration, mining production, refining and smelting, and marketing.

Over the past 10 years, major Australian companies have realized you cannot turn exploration on and off and that economic decisions must be separated from the geological decisions. Increasingly, geologists are under pressure to think innovatively. Old theories need to be challenged. The Olympic Dam discovery of copper and uranium, and three or four other big discoveries of that kind, have shown how geologists can turn known theory right on its head.

Marketing

Australia, like a developing country, has had trouble with its balance of payments. The result is a foreign debt of A$110 billion, with an interest on that debt of $9 billion.

The country earns annually, on exports of goods and services, $40 billion. Even in a good year for commodity prices and with domestic demand depressed, the balance of payments deficit would be $11.5 billion. The foreign debt burden, therefore, is escalating at a rapid rate.

As this debt starts to constrict options, Australians will have to come up with a solution. The typical Australian attitude so far has been to hope for a rise in the commodity prices. After all, this worked in the past! The magnitude of the problem, unfortunately, is so large that there is no likely combination of tonnages and higher commodity prices to pull Australia out of its balance-of-payments/debt constraints this time. We have to do something else.

If we are to survive as an industry, in a country that has dismally failed to control its domestic costs, then we must be smarter than the rest of the world. In other words, the only way for Australia is, not to depend on what is in the ground or running around on the back of sheep, but to develop the ability to finance and market innovative products in a very competitive world. The task is not easy. We live in an area where Taiwan and Korea are formidable competitors in manufactured products.

In the past, Australia has shown an ability to be innovative. The best example is the domestic refrigerator, which was invented in Australia. The next Australian domestic refrigerator, however, will be marketed around the world by one of a lot of very aggressive new companies who have shown they can stand up and rough it with the best of them in world markets. The question is not whether you have the best product, but how the product is marketed. Beer drinkers in Europe and North America, for example, know Foster's Australian label.

Australia in the past has lacked marketing skills, as has the mining industry. Marketing has always been a low priority for mining companies. They understand that to market 10 million tonnes of iron ore is one thing, but to sell cut diamonds into the fashion industry is a very different skill. We must develop brand names which will be recognized throughout the world, and we must have the financial resources and the marketing skills necessary to get out there and sell. That is a new spirit coming into Australia, and one that should transform the mining industry.

Conclusion

So far, the 1980s have been difficult years for most of the world's mining industries. Learning that the world is able to get along with less metal per unit of output has been a painful lesson. The mineral industry's geographical shift from the developed to the developing world is prompting challenges in the area of new leadership. At the same time, higher productivity, more innovative marketing and a greater emphasis on fundamental research to meet the challenge of the new materials are becoming new priorities. With world trade and commercial attention swinging from the Atlantic to the Pacific, enormous opportunities for the rest of this century and beyond are arising. The 1980s were difficult, but the 1990s appear very exciting for the minerals industry.

EMERGING MINERAL TRADE ISSUES

John Cordes

Introduction

My assigned task is to provide some perspectives on emerging mineral trade issues for the remainder of this century. I was encouraged to focus on issues of importance to Canadian mineral producers and policy analysts. Further, my charge was to explore mineral trade issues broadly, but not necessarily to peer into my crystal ball, which in any case has not been in very good working order.

Future mineral trade issues will be defined largely at the intersection of two basic trends. The first depends on the extent to which growing levels of economic nationalism and protectionist sentiment spill over into the mineral sector. This argument has two parts. One is the danger that efforts to correct serious international economic imbalances will lead to a sharp global recession. This would exacerbate mineral market pressures and magnify claims for protection. The other, and for my purposes more interesting, possibility is that a surge in macroeconomic protectionism will replace careful sector-specific assessments of the need to intervene in trade flows.

The second factor in the equation will be the actual evolution of mineral market conditions. The argument is that political pressure points will determine where and how market-mandated adjustments will become contaminated with protectionist measures. The location and intensity of these pressure points will depend on the level of market discipline, the pace of shifting cost advantages in extraction and processing, as well as the nature of sectoral policies.

My approach will be to discuss each of these two trend factors separately and then attempt to derive some insights for the future of minerals trade policy issues. Special attention will be given to the role of the United States. The reasons for doing so reflect the limitations of my familiarity with the issues. More important, I believe mineral trade issues and the evolutionary content of the international political-economic structure will both depend greatly on decisions made in the USA.

The USA is the free world's largest producer and consumer of nonfuel minerals. Competitive dislocations within the domestic producing sector and a growing net-import reliance, have combined to exert strong pressures to erode historical commitments to unimpeded access to the lowest-cost sources of mineral commodities.

In the broader context, the USA was the principal architect, promoter, and protector of the post-World War II international political economy. Her growing frustration with outcomes and with perceived rule-compliance by other trading nations is reaching a threshold point. Aggressive U.S. responses to these frustrations could cause major global disruptions, given the role of the U.S. dollar in international commerce and the importance of U.S. markets.

Free Trade, Fair Trade, and Protectionism

Traditional economic theory provides a powerful argument in support of the domestic and international welfare gains available from free trade based on comparative advantage. Yet, its compelling logic and supporting historical evidence seldom has been sufficient to convince national decision makers. Relatively brief periods of widespread liberalization have been progressively eroded by mechanisms to restrict imports or promote exports. In deference to existing legal regimes and public sensitivities, these new barriers have tended to be more subtle, more complex, more discretionary, and usually more odious than those relied on earlier.

With few exceptions, economists have condemned these practices as misguided attempts to promote regional or national development or to placate powerful political interests. In recent years, however, there has been some rethinking of older slogans and policy prescriptions. While the advocacy of unimpaired trade continues to hold a central place, there is increased awareness that contemporary market complexities may have undermined the validity of simple solutions. These notions of activist trade policies, although speculative and untested, are already beginning to influence policy discussions.

The following two subsections summarize traditional explanations for trade intervention and the newer arguments for activist or strategic trade policies.

Traditional Explanations of Protectionism

Industries within a given country compete at two levels. On the one hand they compete for local and overseas markets with similar producers in other nations. On the other, they compete with dissimilar domestic industries for limited factor resources. If markets are efficient and unburdened by trade barriers, any attempt to promote or protect a given industry will be unambiguously injurious - it will hurt domestic consumers and foreign producers, as well as the interests of other domestic producers. The same arguments apply in the presence of changing comparative advantage. Thus, the protection of a "declining" industry which is losing or has already lost its competitive advantage presumably reduces welfare. Short-term protection of an "infant" industry has been viewed more favourably.

The problem is that shifting comparative advantages (or its corollary, increased trade liberalization) implies domestic income redistribution and inter-industry resource reallocations. The "potential compensation" tests of welfare economics theory make sense in the aggregate, but may be unacceptable to the disadvantaged industrial group. Company loyalties are greatest to their employees, owners, and local communities. Congruence between these special interests and national well-being may be less than obvious, even though this is commonly assumed and always publicly stated. Almost all claims for protection are predicted on pro-national grounds of jobs, national security, regional development, cultural identity, and similar arguments.

In nations committed to "free" trade principles, new import protection measures are granted reluctantly. To be successful, petitioners typically must meet two political, as opposed to legal, tests. One is the need to demonstrate a serious existing or threatened loss of domestic market share not associated with normal market processes. The other is the capacity to organize support without extensive domestic opposition.

The market share/import-reliance test is based on the notion of unacceptable and unfair losses to local producers for reasons outside their control. These losses, in practice, typically result from one or more of three causal factors: shifting comparative production costs, global excess capacity, and macroeconomic policies. When all three factors combine, the pressures for protection become very strong.

Changing comparative advantages/disadvantages are a commonplace fact of economic life. Most of these are accommodated through conventional market processes. Except under extraordinary political conditions, the success of protectionist claims is low. Two explanations are worthy of note. One is that changing natural comparative advantage is usually a slowly maturing process often accommodated by changing patterns of foreign investment. The second reflects the fact that many potential expressions of comparative advantage (for example those in "invisible" trade categories such as services and intellectual property) are blocked by explicit rules and regulations very early in the process, i.e., before conflicts and declining domestic market share problems arise.

Pressures for microeconomic intervention policies are greatest when a group of countries simultaneously must face structural adjustment problems in a given sector. This condition arises most commonly when global excess capacity pushes prices below remunerative levels. Structural surplus capacity is a complex, usually unexpected phenomenon caused by the cumulative interaction of at least three factors. The first is a rising capital-intensity of production. The second is the presence of aggressive new entrants whose capacity additions are typically:

- trade-dedicated because local market absorption is low;
- cost-competitive for natural and/or policy support reasons;
- heavily burdened by debt repayment obligations;
- viewed as an important source of employment and foreign exchange.

These two factors, rising capital intensity and new entrants, interact to increase competitive pressures and to raise the actual and perceived cost of idle capacity.

The third and decisive factor is an unanticipated decline or stagnation in demand growth for the sector's output. Extreme pressure is placed on producers whose effective costs are in the higher quadrants of the global supply function.

Traditional economic theory does not provide politically acceptable solutions to this problem for a given sector, let alone its simultaneous expression in many sectors. At the macroeconomic level, there are strong advantages for slow, nondisruptive evolution in productive structures so as to avoid destabilizing the whole domestic economic system. At the microeconomic level, close-down options will be resisted in favour of claims for protection, global sharing of adjustment burdens, and imposition of disincentives to new capacity creation, regardless of its inherent economic status.

A natural byproduct of prolonged excess capacity is the reassessment of trade rules. General adherence to the virtues of free markets and willingness to "accept the world as it is" gives way to intense scrutiny of unfair trade practices. Firms under siege are less concerned with the linkages between cause and remedy than in justifying their claims for survival.

Here it is useful to emphasize that doctrinal pursuit of free trade is meaningless in the absence of established rules or boundaries for legitimate governmental actions. The virtue of free trade is that it is fair trade. In the frictionless, timeless, costless adjustment process of textbook economics, domestic consumers and the economy itself gains when other nations subsidize their exports. In the real political economy, the dilemma of retaliation or sending thank-you notes is more problematic.

The third source of declining competitiveness can be traced to pronounced distortions flowing from macroeconomic policies. The most obvious of these are misaligned exchange rates - an overvalued currency decreases a nation's competitiveness in local and foreign markets. For example, a 30-percent appreciation translates to an effective 30-percent subsidy for foreign-based imports and an equivalent tax on domestic exports to overseas markets. Alternatively, a discretionary devaluation by a competitor has the same general impact. Indeed, some commentators see manipulation of exchange rates as a policy variable in pursuit of comparative cost advantages. If true, this is a major deviation from post-WWII assumptions which viewed the international monetary system as a stabilizing force and lubricant for increased trade flows.

Whether exchange rate movements are derived from overall macroeconomic policies or from discrete policy decisions, the impact is the same. The effect is felt by all trade-competing producers and especially those in sectors characterized by shifting comparative advantages, surplus capacity, and weak access to product differentiation. When prolonged imbalances exist, a "we-they" syndrome emerges which eases the burden of proof for would-be protectionists. A macro-sensitivity in favour of comprehensive protection is likely to grow both in terms of import relief and in terms of market access.

The constraint on market-share claims for protection is based on the second political test: the need to organize import relief support without significant domestic opposition. On its face, the political economy is biased in favour of protectionism. Winners are generally few and can demonstrate the magnitude of threatened injury. Consumers who stand to lose from protection remedies are widely dispersed and incur only marginal injury as individuals.

In practice, this presumption is too simple. National policy makers do make decisions broadly consistent with a sense of the national interest.

The Role of Activist Trade Policies

Traditional micro-interventionist policies have been based on reducing or slowing dislocations incurred by comparatively immobile domestic groups threatened by the internationalization of productive capabilities. There was no presumption of pervasive malign intent.

More recent inquires are much less sanguine about the causes and impacts of trade patterns. These efforts are not so much a challenge to the desirability of free trade as they are a challenge to the naiveté of a country adhering to free-trade policies in the presence of extensive unfair trade practices by other nations. This line of investigation moves the focus somewhat from traditional accommodation of shifting exogenous forces of comparative advantage to game-theoretic strategies which also include endogenous sources of comparative advantage. In some sense, the central issue becomes whether the case against intervention is changed if trading partners persist in intervention.

For my purposes, three questions are of importance. First, does a major country ideologically committed to free trade and slow to retaliate actually contribute to exploitative trade intervention by other nations? Traditional free-trade theory argues that even unilateral free trade is preferred to domestic protection, so that from a free trader's position this would be a non-issue. Eventually foreign subsidizers would realize the destructiveness of their policies. In modern market conditions, however, this logic may not apply. If rule violation injures the opportunistic country less than it does the free trader, the former may gain a strategic advantage. Although both would gain by rule-conformity, only the threat or implementation of retaliation is likely to result in preferred outcomes.

The other two questions are related. The first asks when and under which conditions does the contraction of a domestic sector actually harm the national economy. The second queries whether national welfare can be enhanced in the long run by discretionary support of some sectors. Both questions mix trade policy with industrial policy issues. The appropriate national policy question is: What mix of domestic productive capacity is necessary for overall national economic performance and security?

Answers to these questions are difficult to define and defend objectively. Evidence suggests that most countries reject purely neutral policies in favour of some internal concept of acceptable industrial bases. Somewhat belatedly the issue has become important to the USA and underlies increasing calls for reciprocity in trade policies and adherence to something called a "level playing field".

Before continuing, I would like to make an additional observation. Notwithstanding the political and, in some ways, economic attractiveness of activist industrial policy, it has serious problems especially when commingled with trade policies. The major problem is in the identification of strategic sectors - whether governments or markets should pick winners and losers.

On the defensive side, most basic industries argue they have strategic value and need to be maintained for national security reasons. If predatory trade practices destroy their competitiveness, security would be eroded and the nation's economic (and military) position will be imperiled. In the presence of alleged worldwide sectoral planning, basic industries in the USA and elsewhere will become residual castaways. The policy question is to define truly strategic sectors, if any, and to separate out issues of import vulnerability and unfair competitive practices.

In economic theory terms, traditional and activist views of trade intervention return to the same basic dilemma. Intervention is rational only when it benefits the nation as a whole. Retaliatory intervention cannot be based solely on the argument that it compensates for another country's action. Countervail is defendable most easily when the resulting action was desirable before the fact - an issue of industrial policy. Still, this does not erode the need for permitting firms to compete under fair-trade rules.

The problems on the sunrise industry side are similarly complex. Picking winners is probably more difficult than identifying losers or declining sectors. At the same time, fair-trade questions remain of concern.

The International Political Economy in Transition

In response to decades of economic chaos, the post-WWII international economic system was based on a structure of rules and institutions designed to promote monetary stability and progressive trade liberalization. Widespread voluntary conformity to the spirit, if not to the letter, of this regime resulted in a 30-year period of economic growth and prosperity unprecendented in human history: trade in manufactured goods increased dramatically; the consumption of the raw materials needed to fuel and feed manufacturing processes grew at historical rates; the green revolution transformed agricultural productivity and markets. Revolutionary technological changes were both the cause and the result of this boom in economic activity. These advances and their rapid diffusion contributed to rising comfort levels and expectations while simultaneously hastening the pace of shifting comparative advantages.

By the early 1970s, the system's capacity to cope with the pressures its success had unleashed became an issue of concern. Events during the past decades have raised these questions to levels of greater urgency. Today, more than 150 nations are struggling with the structural adjustment problems inherent in modern interdependence.

The proximate cause of disarray is an errosion of respect for market forces, or at least an unwillingness to accept their dispassionate judgments. Stated differently, the events of the past two decades have reactivated two of the perennial questions in political economy. The first, to paraphrase Susan Strange,[1] is whether an international economic system which gives power to the market is compatible over time with an international political system which gives power to diverse sovereign states. The second is whether the application of uniform rules to economic interactions among unequal nations is appropriate or likely to yield acceptable outcomes.

The essence of an international system is that its "rules" must have strong consequential impact on national policies. The system's sustainability must be based on governmental perceptions that the expected benefits associated with rule compliance exceed those available from opportunistic deviations. Historical evidence suggests these conditions exist only when the international political economy is organized as a hierarchy dominated by a hegemonic power. When the hierarchy "flattens" and/or the hegemon's willingness and ability to act as arbiter declines, autarchy and bilateralism rise to prominence. The major questions, then, become how to minimize disruptive crises and how to rebuild an effective international system.

The post-WWII regime apparently has evolved to the point where these questions must be addressed actively in light of the perennial dilemmas noted above. Since political-economic realities are much more complex than they were in 1944, it is unlikely that creating a new regime is feasible. Thus, intermediate responses are necessary. The issues are when and how nations adjust to the realities of interdependence, not whether they do so. Success will depend on the system's capacity to establish disincentives for

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1. S. Strange, "The Management of Surplus Capacity: Or, How Does Theory Stand Up to Protectionism 1970s Style?" International Organization, vol. 33, (Summer), 1979, pp. 303-334.

the growing tendency of governments to use the international economy to avoid confronting difficult domestic troubles such as deficits, unemployment, regional development needs, and lack of competitiveness. This, in turn, will require greater agreement (and enforcement) of rules for acceptable and unacceptable policies. Many of these issues fall under the broad rubric of trade policy.

The United States and the International Political Economy

The United States has been the acknowledged leader of the international political and economic system for over 40 years. For most of this period, its decisions provided a "public good" in support of trade liberalization and cooperation. Views on U.S. leadership vary between benevolence and exploitation. Adherents to the latter see the push for progressive openness in international commerce as serving U.S. interests and competitive advantages. Others view U.S. leadership as accepting asymmetric adjustment burdens by temporarily permitting first developed and then developing countries to claim "free-rider" privileges.

Regardless of which view of the past is preferred, modern realities must be accommodated in the search for a prosperous future. The USA remains the world's largest and most important economy and the home of the world's key currency. Yet she can no longer play the role of the system's hegemonic leader by herself. Over the past 35 years, the U.S. share of global gross domestic product and value of exports has declined by nearly 50 percent in the face of rapid worldwide economic growth. More recently, the USA has become the world's largest debtor nation, and her economy has become increasingly sensitive to global economic trends. As a result, the USA has become preoccupied with her own threatened economic interests. At the same time, there is no substitute world hegemon in sight. "Surplus" nations such as Japan and the Federal Republic of Germany are both unable and unwilling to assume the responsibilities of significant leadership. The leadership vacuum must be replaced with new cooperative economic policies. Governments must recognize the blurred distinction between domestic and international economic policies. Today it is necessary for major economies to discuss, and often negotiate, domestic economic policies with their trading partners.

In a politically active world, where freedom of action is a highly prized national prerogative, this is no small task. While nearly everyone recognizes that serious economic debt, trade, and currency imbalances threaten more serious economic and political disruptions, little agreement exists on causes and remedies. Some argue that the U.S. budget deficit is the main culprit and that the USA needs to establish greater domestic discipline. In order to accomplish this, the USA will have to produce more than it consumes. This means the country must significantly increase its net exports, i.e. improve both its competitiveness and its access to overseas markets. Depending on how you view the needed sharing of adjustments, other countries must either spur their domestic growth to increase demand for U.S. exports and help sustain developing countries, or they must reinflate their economies and reduce their competitiveness. There must also be a further decline in the value of the U.S. dollar. Resistance to these choices is apparent.

Numerous "hard-and-soft-landing" scenarios to the current economic imbalances have been put forth. Soft-landing scenarios are ultimately based on a presumption of shared responsibility for adjustment between a small group of major developed countries. I am particularly impressed with Bergsten's[2] arguments for "bigemony" between the USA and Japan because the major problematical imbalances exist between these two economic powers. Cooperation and coordination between them, at least at an informal level, promise to defuse crises and promote longer-term solutions.

I am hopeful that the harsh lessons of the interwar period will not have to be relearned. In the search for solutions for global accommodation, there remains the possibility that major trading countries will slip into more broad-based protectionism in the near term.

I would now like to look briefly at this issue from the U.S. perspective. As the world's largest export market, a U.S. move to protectionism is greatly feared by Canada and most other countries. Reduced access to U.S. markets would seriously undermine their economic performance and stability - few other residual markets are open to them.

In many ways these fears are justified. Protectionist sentiment is higher in the USA today than at any other time I can remember. The reasons for this sentiment are both factual and psychological. On the latter plane several factors are relevant. First, the USA had become comfortable with its historically-earned image as a preeminent world power. Its current trade and competitive difficulties are widely viewed as externally inflicted. Thus, the problem is not a diminishing of the USA, but a prolonged U.S. failure

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2. C.F. Bergsten, "Economic Imbalances and World Politics", Foreign Affairs, vol. 65, no. 4 (Spring), 1987, pp. 770-794.

to insist on her own rights. Added to this is a sense of global ingratitude for years of sacrifice to promote and permit the overseas economic development which now challenges U.S. producers.

These views result in arguments that the USA should now recognize that the goal of free trade is a mirage. Paternalistic focus on broad multilateral stability has made the USA the world's dumping ground for global production and permitted others to exclude U.S. production. Fair trade and reciprocity should become the guiding rules for U.S. policy. Two variations of this are sufficient for the point.

1. (Many efforts take) no account of an array of discriminatory practices imposed by other nations ... Shielding industries from competition is one thing, insisting that they be permitted to compete is another. The issue today is less protecting American industries than gaining access to foreign markets ... New thinking is required ... it should begin by acknowledging that Americans are producers as well as consumers.[3]

2. For too long, we have dealt on a multilateral basis when we should be dealing on a bilateral basis - following the simple rule that access to this country's markets may be gained only when we enjoy similar access, but not just in areas where our products have a disadvantage. Their citizens and companies could do nothing in the USA that we are precluded from doing in their country (either basic or service industries). This is not protection. It has nothing to do with tariffs or quotas. It is simply reciprocity as the basis for trade until trade deficits reach acceptable levels.[4]

But the factual basis behind U.S. protectionist sentiment is also important. Record trade deficits have stimulated concern over the adequacy of U.S. trade policies. Even recognition that U.S. budget deficits are the major cause of U.S. trade problems has not lessened growing concern over global trade and industrial policy trends.

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3. Bhadwati and Irwin, "The Return of the Reciprocitarians - U.S. Trade Policy Today," Foreign Affairs, Vol. 10, no. 2 (June), 1987, pp. 109-130.
4. K.J. Barr, "The Challenge Facing Mining is to Survive Foreign Competition," American Mining Congress Journal, May 1987, pp. 13-14.

By almost any definition, the USA continues as the most open major trading country in the world. Organization for Economic Cooperation and Development (OECD) statistics also portray the USA as having the lowest level of subsidization among industrial nations. While definitions are crucial to any ranking, these facts reflect a 40-year effort on the part of successive U.S. administrations to promote elements of free trade.

This does not imply that the USA is above reproach. The General Agreement on Tariffs and Trade (GATT) system itself has always been based on negotiation and arbitration in support of reduced trade barriers, not adherence to a free-trade ideal. Protectionism has always been present and often sanctioned. Evidence of U.S. subsidies and sectoral import protection are not difficult to enumerate.

For almost everyone in the USA, competitiveness and fair trade have become the buzz words of the 1980s. Yet these words can be the ally or the enemy of openness and liberalized trade flows. From the U.S. perspective, they can become excuses for inadequate performance, justification for procedures to harass successful competitors, and permission to focus on outcomes rather than on rules of fair play. Alternatively, they can become levers to reestablish definitions of acceptable governmental practices and penalties for unacceptable interventions.

In my view, finding a perspective on the meaning and effective implementation of fair trade and fair competition lies at the heart of world trade and industrial policy disputes. I believe it unfair to label the U.S. concern for fairness as a code word for doing things the American way as some have suggested. Moreover, I find the Canadian proclivity for the phrase "contingent U.S. pertectionism" to be unnecessarily negative. Both countries maintain their share of protectionist devices. That U.S. actions may injure Canadian interests more than similar Canadian actions would harm U.S. interests, is a fact of size, not of legitimacy.

The subsidies fair-trade issue is of particular interest to us today. As David Anderson so ably demonstrated in a recent paper, the question of subsidies in traditional industries is a complex problem.[5] His suggestion for a net/net subsidy test makes analytical sense, but defies, as he recognizes, current measurement capabilities. His paper poses the question quite well from the non-U.S. perspective: "How can a nation (read Canada) exercise its sovereign rights without engaging in some practices which are deemed by others (read the USA) to confer subsidies?" From the U.S. perspective, safeguard legislation, such as that embodied in antidumping and countervailing duty laws, are transparent systems for dealing with inappropriate pricing and subsidy practices. From the two perspectives, the same laws are divergently viewed as harassing threats to sovereign expression and necessary correctives to an undisciplined and hostile or opportunistic world. The curiosity in Anderson's query is that somehow U.S. trade legislation is an "unfair" expression of U.S. sovereignty while Canadian regional and industrial policies are justified sovereign prerogatives.

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[5] D.L. Anderson, "Mineral Subsidies: A Canadian Perspective" (Paper presented at Colorado School of Mines, January, 1987).

Trade law and trade-remedy law cannot be static. They must always reflect emerging conditions, in the absence of well-defined and binding transnational rules. Unless predictability in outcome is raised to a higher plane than transnational relations have traditionally assumed, I fail to see a greater evil in U.S. trade rules than in the panoply of static, but effective, subsidies and prohibitions confronting U.S. firms. The problem, obviously, concerns definitions and self-interests.

At the bilateral U.S.-Canadian level, the passion of the issue and perhaps some of its ultimate essence (size differentials) can be seen in a recent article by Rugman.[6] Prior to his provocative conclusion that U.S. trade policy "is a policy which exceeds the GATT subsidies code and is hardly 'fair' by any standards," he presents the following assessment.

> An independent analysis of the manner in which U.S. trade law is being used by U.S. producers brings into question the ITC's (International Trade Commission's) overtly sanguine interpretation of its administration of U.S. trade policy. Instead, it appears that many U.S. companies are systematically exploiting U.S. trade laws to protect themselves from Canadian competition; neo-mercantilism has reared its head.
>
> The pernicious cost of protection stemming from the application of current U.S. trade law is borne by American consumers and Canadian exporters. American consumers pay for higher

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[6] Rugman, A.M., "U.S. Protectionism and Canadian Trade Policy," Journal of World Trade Law, vol. 20, no. 4, 1986, pp. 363-380.

> priced imports, and for inefficient (i.e., above world price) domestic production which is only feasible behind the tariff wall erected by the ITC. The current administration of U.S. trade laws reflects the anarchy of U.S. trade policy. Enshrined in the ITC is an autonomous, quasi-judicial process which permits private corporations to file petitions which must be voted upon under severe time limits, usually to the detriment of objectivity and the foreigners.
>
> It is not a feasible policy for Canada to retaliate against U.S. trade policy by using anti-dumping and countervailing duty laws of its own (although it has the power to do so by the Special Measures Import Act passed in 1984). This is due to the asymmetry in size of the U.S. and Canadian economies. While a U.S. producer can petition the U.S. ITC and hope to earn countervailing duties or other forms of protections against a Canadian exporter selling to a market ten times the size of his home market, a Canadian protectionist producer would only be able to petition to cut off one tenth of the market for a U.S.-based producer.

Following are few final comments about overall U.S. trade policy tends and issues. First, I wish to emphasize that the fair-trade issue is real. Neither the USA nor Canada, nor any other country, will accept being put in a position where its producers are denied access to remedies against unfair competitor practices. The subsidy/fair-trade nexus has defied solution since the mid-1960s when it again became viewed as trade-distorting. The traditional approach has been to expand GATT's basic hostility to subsidies while permitting national countervail and other safeguards.

Perhaps the recent U.S.-Canadian free trade negotiations will lead to a fresh perspective on resolving these issues, both bilaterally and multilaterally. Somehow, major trading countries must reach accord on which domestic policies, or combinations of policies, are actionable distortions of trade and which are not.

Second, just as I am hopeful major international economic chaos will be avoided, I am optimistic the USA will not slip into widespread macroeconomic protectionism. What appears as decentralized, chaotic, and unfocused U.S. trade policy formation structures to Rugman and others, has historically been a careful balancing of U.S. domestic and foreign policy concerns. U.S. global responsibilities necessitate rule-based retaliation rather than lashing-out responses. Shows of threat, even in frustration, are unlikely to result in defensive noncooperation. Too many crucial global alliances and strategic relationships are at stake to permit economic discord to get out of hand. Stop-go trade policies are unavailable to the USA if she continues to accept her leadership position.

If push comes to shove, the USA is more likely to "join the opposition" by adopting activist industrial policies through the discretionary use of supporting regulations - taxes and subsidies - along with relaxation or resharing of the burden of government-mandated costs.

Finally, I would expect greater emphasis on bilateral and minilateral negotations to deal with difficult problems. This trend is already widely evident in U.S. responses to trade, currency, and debt diplomacy. The U.S.-Canadian agreement draft is merely the most recent of a growing list of formal and informal negotiations. I expect them to proliferate. Non-U.S. minilateralism can also be expected to grow.

Even though I am confident an undisciplined slide into economic chaos, trade wars, and wholesale U.S. protectionism will be avoided, the intensity of issues surrounding fair trade and competitiveness suggest troubled times for some industrial sectors. Primary product industries are the most vulnerable. Agricultural policies have gotten out of hand. The dangerous vehicle of voluntary export restraints and orderly market agreements appears to have become a politically acceptable way to defuse pressure points. These agreements, which substitute outcomes for rules, are especially seductive and pernicious. Because they aid both domestic and foreign producers, they have become convenient ways to avoid conflict and, possibly, legal entanglements.

Minerals Trade and Policy

The intensity of transnational mineral policy issues belie their recent origin. Only during the past decade have these trade questions risen to high places on the political agendas of major trading countries. Even so, the issues of concern have flipped significantly. Prior to the 1980s, the perceived threat was availability of supplies. Trade diplomacy focused on international rules to assure equitable access to supplies. Today, concerns are based on predictable access to markets and mitigating injuries from overly rapid structural adjustment.

The preceding discussions provide a useful background for investigating current and emerging nonfuel mineral policy issues. Structural changes and macroeconomic imbalances have resulted in persistent excess capacity with its attendant pressures on competitiveness and structural adjustment. Allegations of unfair trade practices and threatened national security are commonplace at industry association meetings. Even significant industrial restructuring, cost and technological improvements, and a buoyancy in prices, have not reduced perceived urgency in the underlying conflicts. Fair-trade and competitiveness issues are likely to be around for some time in the minerals industry.

The remaining text will focus first on recent and current mineral policy issues, then on an assessment of whether future industry conditions are likely to result in policy modifications. Historical and current factors conveniently separate political jurisdictions into several player groups. For simplicity I exclude the centrally planned economies, although diehard adherents to the "resources war" mythology might object.

The first group is defined by its interest in access to overseas markets. In these countries, mineral investments are trade dedicated and often portrayed as leading national or regional sectors. The latter claim has been, at least historically, a convenient argument for special macroeconomic treatment. The survival of these investments depends on overseas demand for their output. At the same time, the interests of individual members are less than uniform.

The mineral-exporting developing countries, a subgroup to this first group, broadly share natural comparative advantages in geology and low labour costs. They also share the advantages and disadvantages of an extensive public sector involvement in production and regulation. When these factors are combined with large foreign debt burdens, access to markets becomes of prime concern, and real (or at least perceived) fixed-to-variable cost ratios require foreign exchange revenue maximization. Some evidence suggests their supply curves contain downward-sloping segments at low prices.

Another part of the trade-dedicated group are the supersufficient members, such as Canada and Australia. These countries have similar access interests, but are unlikely to claim as much support for their automatic survivability. Labour costs and socially justified government-mandated costs are likely to make these producers less competitive and flexible in the marketplace. During tough times, their interests are likely to be fragmented. On the one hand, they argue for basic principles of free trade to their existing and potential consumers. On the other, they lament unfair access to financing, unfair positive and negative subsidies, and other special privileges allegedly flowing to developing country producers.

The second group combines much of western Europe, Japan and the resource-poor, but rapidly industrializing nations of Asia. These countries operate largely as oligopolistic rentiers. Their principle concern is in securing readily available, low-cost supplies of minerals or mineral products at the appropriate level of processing. With the partial exception of parts of Europe, low prices and excess global capacity are preferred because they have few domestic mineral producers to contend with or appease.

The outlier in this equation is the third group of one - the United States. The USA is the free world's largest producer and consumer of minerals, yet historical and other factors combine to make minerals policy issues extremely complex. Fair trade and competitiveness issues in the USA are a recent phenomenon. Until well into the 1970s, U.S.-domiciled producers supplied a very large percentage of U.S. consumption needs from local production and overseas operations under their control. U.S. bar charts depicting net-import reliance have always been a bit deceptive in their limited coverage and definitions.

The USA has never established a coherent, comprehensive nonfuels mineral policy. In part this reflects a historical disinclination toward sectorally-based industrial policy. As important, mineral issues seldom have been seen as urgent enough to demand special attention. Although minerals, like agricultural goods, can be viewed as essential building blocks of an industrial country, this view has not been converted at the policy level to a rationale for stand-alone consideration. Steel is a glaring exception.

Nor is there current interest or movement toward a U.S. minerals industry policy, even though there has been a resurgence of interest in the implications of net-import reliance. Recurrent legislation calling for a sound and prosperous U.S. domestic mining industry has never extended to provisions for specifying the content of policy instruments or to the tools to enforce compliance.

Recent deviations from a longstanding U.S. preference for open access to the lowest cost world supplies of minerals have been grounded in fears of excessive erosion of its basic industrial base and in a perception of unfair trade practices. A brief response to both these arguments follows.

While the national security argument has a long history, the U.S. mining industry has been unable to make a compelling case in defense of preferential treatment. Approval of the U.S.-Canadian free trade agreement will further erode the capacity to deliver on the argument. In essence, the issue comes down to secure availability of supplies or vulnerability to shortfalls for military and manufacturing needs. Vulnerability is not the same thing as dependency on imports. The latter is merely a ratio; the former implies a serious cost. Nations are mineral-vulnerable only if they lack effective policy response options which are cost-effective. In the absence of believable cartel or embargo threats, vulnerability potentials are solved by stockpiles and promoting diverse, safe supply sources in the short run. For traditional minerals, including most so-called critical and strategic minerals, effective U.S. vulnerability, barring any notion of a "resources war", is small.

While the USA has a self-sufficiency option for most minerals, cost factors have precluded any effort in this direction beyond basic stockpiling. Of principal concern was the competitive position of downstream users. Without a direct subsidization program, locally provided mineral costs would place these producers out of the market.

More recent security concerns take a slightly different approach. If mining activity is greatly reduced in the USA, will processing and semi-fabricating also become uncompetitive due to value-added support policies by overseas producers and/or differential cost factors? If so, what are the implications for the U.S. industrial mix and its future vitality. Alternatively, how far towards a "high-tech" and "service" economy can a legitimate world political, economic, and military power go without undermining its credibility? This is a more demanding consideration than simple stockpiling or analogy with Japan and other resource-dependent countries. Coupled with this issue is the growing question of regional disparities within the USA.

These questions increasingly underlie domestic U.S. policy questions of access to potentially mineralized lands, sharing the burden of environmental and other regulations. If this case were made and implemented, one could expect improvement in U.S. minerals competitiveness and a reduction in unfair trade arguments. It would also promote greater public and private sector cooperation than has recently been in evidence.

Allegations of unfair trade practices are more difficult to deal with objectively, even when one accepts the difficulty of universal definitions. In approaching this issue, I want to accept *a priori* many ore-grade, polymetallic distribution, and other geological disadvantages some U.S. producers face with existing deposits. I would also like to accept that in lobbying one always calls attention to competitor misdeeds while ignoring one's own. I would even add that no established industrial group wants to see its threatened future as anything short of full revitalization.

The question of fairness is still real. One need only quote page after page from the Mining Association of Canada's 1985 submission, "Economic Renewal and Canadian Mining," to see its litany of concerns similar to the 1986 American Mining Congress's "Declaration of Policy". Both devote major attention to unfair practices and undesired treatment, ranging from competitiveness, reducing governmental regulations, concessionary financing, generalized system of preferences, etc. Indeed, the documents largely mirror each other, except that Canadians focus on competition with other exporters, while the USA is concerned with import competition.

As a law student many years ago, I was inculcated with the "ox-goring" approach to looking at the structure of conflicts. In essence, you don't yell unless a remedy is in sight, and then you "yell like hell". Both U.S. and Canadian mineral producers have yelled a lot during this decade. Perhaps they have something to yell about, both in terms of their common claims *vis-a-vis* third countries and bilaterally.

Bilateral yelling probably is the natural byproduct of different traditions and felt needs. Thus, legitimate Canadian mineral industry policy may be export-promoting, while legitimate U.S. industrial policy may be import-restricting. In this sense, Anderson, Rugman, and others are correct in alleging that the U.S. safeguard system is biased in favour of U.S. producers. But all industrial policy is producer-biased, at least in the short run. Export-promoting industrial policies would fail the same neutrality test even though we call them "incentives". Yet the visibility of the alternative policy approaches differ. Regional development and export promotion often are seen as legitimate expressions, even obligations, of a sovereign's economic policy. Import restriction is viewed as abuse of discretion. Without definitions, the public relations die are loaded. A cynic might even suggest Canadian unwillingness to accept a code of acceptable "subsidy" practices during recent bilateral discussions was informed by a fear of needing to choose between access to the U.S. market and the ability to compete with other overseas producers. One wonders if a U.S. regional and/or industrial policy in direct support of domestic mining activities would meet Canadian "legitimacy" tests.

In general, U.S. mineral producers have access to a comparatively rich menu of safeguard mechanisms under U.S. trade law. Given the complex production/consumption, import/export nature of the U.S. economy and her tradition of rules ultimately subject to litigation, this should not be surprising. Yet only recently have these remedy provisions been viewed as offering much relief. Even now the prospects of success are so low that industries have been asking Congress for legislative solutions to their problems.

One well-known remedy is the section 201 escape clause relief that provides temporary protection from excessive or disruptive import competition. Its advantage is that petitioners do not need to prove unfair practices. Although lead, zinc, copper, ferromanganese, ferrochrome, and other producer groups have petitioned, only one has been successful. For a brief period, ferrochrome imports into the U.S. at below a target price were subject to a 4-cent per pound tariff.

Antidumping and countervail remedies, based on "unfair" practices tests, have not been very successful. Cement failed where potash provisionally won recent antidumping petitions. I cannot think of a successful countervail success in the minerals area. Other recent U.S. mineral sector remedies are a four-year "orderly marketing agreement" with China covering tungsten products, and recent efforts to void general preference status for molybdenum and columbium imports from Chile and Brazil, respectively. Producers in the USA are also likely to resist Zimbabwe's request for preferential duty-free treatment of its ferroalloy exports.

The reasons why U.S. mineral producers have not been very successful reflect several factors. One is the multi-part structure of the process which requires presidential approval. U.S. presidents have consistently been biased in favour of free trade for both foreign policy and domestic interest reasons. Moreover, the U.S. mining industry has not been able to obtain strong public support - it has very little political standing. Second, protection of mining is almost always seen as increasing the cost of downstream users more vital to U.S. industry and employing more workers. Only in-high price/low-volume commodities, which constitute negligible percentages of final good costs, is success even likely.

While Canadians may rightly lament that these remedy laws are time-consuming and costly to respondents, one must always remember foreign interests have access to U.S. courts in these matters. U.S. competitors do not have similar access to Canadian courts to challenge the validity of allegedly subsidizing governmental practices which disadvantage them.

The recent U.S.-Canadian accord may ultimately provide a healthy response to these difficulties. As I understand it, the presented document calls for the eventual development of a new code to replace the transitory dispute settlement mechanism which is bound to declaratory opinions based on interpretation of existing national laws. If the new code provides transparency, and bounds acceptable and unacceptable governmental practices, the agreement will yield impressive results. No bright line tests can ever be drawn in the subsidy countervail and related areas. Yet some assessment of benefits granted and governmental intent are essential components of any standard.

Conclusions

Except for a small number of countries, nonfuel mineral trade issues remain relatively unimportant. Major industrial countries have a strong and continuing interest in sufficient supplies of materials at low prices. I see little evidence of a shift from this view in the USA. The very few actual or potential deviations toward U.S. minerals "protectionism" during the mid-1980s do not suggest any kind of trend. I believe the USA accepts the likelihood of growing net-import reliance percentages. Surely, I cannot foresee aggressive measures to stem the tide if it risks a two-tier international price system to the disadvantage of domestic material users. I am not very sanguine about adjustments in U.S. regulatory policies which could enhance competitiveness of local production.

Let me conclude with a few comments on factors or events which could increase tensions and provoke movements away from current policies. These comments are based on three reasonably obvious propositions. First, healthy and stable mineral markets ease pressures on governmental policy formation. The difference between slow shifts in comparative advantage and the undisciplined disruption inherent in persistent surplus capacity is significant. Second, healthy and stable world economic growth has a similar effect. Third, I see little evidence that developed countries will move away from the problems of developing countries, at least insofar as they involve their trade practices and preferences. Subjecting these nations to the same rules applied to larger, more prosperous nations is at best a talking point.

My first observation has to do with market discipline. Most mineral markets have been in persistent oversupply for the past decade. Much of this was the result of unexpected stagnation, even decline, in consumer demand. For reasons alluded to earlier, market discipline was low and the adjustment burdens were unevenly shared. Much of this has now worked its way out of the system and the appearance of health has returned.

The real questions are: (1) has excess capacity really been extracted from the marketplace or is it just lying in wait, and (2) will future excess capacity be avoided, given the shelf full of deposits waiting development. The great reality of current secular demand trends is that shifting comparative advantages will be more difficult to accommodate without market-sensitive discipline. Higher cost producers may suffer more with slow demand growth. More competitive producers will see their gains in capacity growth occurring more slowly. Global expansion of capacity inconsistent with depletion and demand rates may be a misallocation of capital. It will surely rekindle trade policy pressures.

A related and even more interesting question is what impact the growth of advanced materials will have on the minerals industry and on policy. From the U.S. perspective, rapid substitution will create competing pressures. On the one hand, domestic producers will face serious erosion of their position in the market and increased pressure from overseas claims on market share. On the other, U.S. policy is likely to focus more than it already does on "high tech" issues. Indeed, the growth of advanced materials and applications may be the greatest unknown in the future of mineral policy issues.

My second observation focuses on exchange rate movements. Since nearly all minerals are traded in U.S. dollars, the likely further depreciation in dollar values will alter comparative advantages. This is happening in steel and aluminum, for example. Moreover, the linkage between metal prices and exchange rates remains unclear. Recent years have seen a persistent decline in the dollar's value while metals prices first fell, then rose. If the former, coupled with excess capacity, prevails, developing countries may be pressured to push capacity utilization. None of this speaks to mineral price cyclicality and its attendant pressures nor to the implications of a global recession at the end of 1988.

Finally, a comment on the U.S.-Canadian draft agreement. Although I have not assessed its longer-term impact, several casual observations may be appropriate. As it currently stands, Canadian mineral producers appear to have gained significantly. Few U.S. producers are likely to support ratification. To the extent that rules of origin are enforced, the agreement is likely to be trade-distorting to the disadvantage of Third World producers in particular. If Canadian producers expand output and downstream processing, more dislocations are likely. One can expect U.S. producers to scrutinize imports from developing countries more aggressively. Ironically, one can also expect Canadian producers to take a more supportive interest in U.S. "contingent protection" applied to third countries. In the absence of greater U.S.-Canadian dollar exchange rate parity, the content of future American Metal Congress and the Mining Association of Canada declarations may become much more similar. At the same time, we are all likely to discover the exchange-rate movements are much more important variables than tariff rates and trade-remedy rules.

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WORLD SUPPLY-DEMAND PATTERN FOR METALS IN THE 1990s

Simon Hunt

We are passing through such uncertain times that the ability to grasp the issues which help shape our world and the metals industry in which we are all involved, become faint, if not elusive. Indeed, judgment about the future is invariably influenced by recent experience, which is not always a particularly gratifying prospect for the metals industry. With the recent increase in so many metal prices, I venture to suggest that many long-term price forecasts have been raised, prompting me to sub-title this paper "Deja vu", or, "1978-1980 Revisited". Nonetheless, as an errant philosopher once remarked, "You can't change the past, but you can sure ruin the present by worrying about the future".

In looking at the future, lessons should be drawn from the past. As George Orwell said, "Who controls the past controls the future, who controls the present controls the past." Therefore, for each of the metals discussed in detail - copper, aluminum and zinc - I will draw comparisons with what happened in the last ten years to place our forecasts into perspective. There are three developments common to all metals though in varying degrees:

- the sharp reduction in costs in recent years;
- limited investment in new projects;
- a better growth rate of consumption than many dared hope back in 1982.

The combination of these factors has led to the current strong prices for many metals, notably aluminum copper, lead and nickel.

Reduction in Costs

Copper

In the last five years average western world cash operating costs for copper have fallen by 36.8 percent to 44.4 c/lb in 1986, and cash costs plus interest by 34.7 percent to 49.4 c/lb in the same period. The cost pattern has also changed substantially. Zaire has moved from being the lowest, mainly because of lower cobalt prices, to just above Chile or 30 percent up the cost curve; Canada's relative competitiveness has deteriorated along with that of Peru, the Philippines and Mexico. The USA, while considerably reducing its costs, remains in the same relative position. Improvements are noticeable for Chile, Zambia, South Africa, Papua New Guinea (PNG) and Australia.

One significant reason why costs have declined has been the large drop in labour costs in terms of cents per pound of copper produced, as shown in figure 1. The largest drop has been in the USA with costs falling by 55 percent to 16.2 c/lb in 1986, closely followed by Chile (-53 percent) and Zambia (-51 percent). In 1981 only Australia and the USA showed above-average labour costs; in 1986 it was the same two countries with Canada just above the average and Chile just below. Note, too, that the range has narrowed from 22.5 cents in 1981 to just 5 cents per pound of copper in 1986.

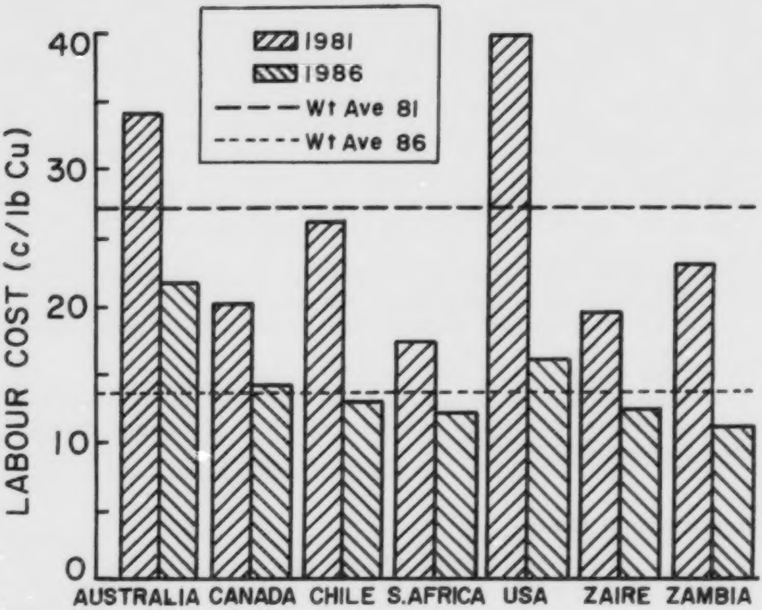

Figure 1. Labour Costs in Copper Production, 1981 and 1986.

Interestingly, the cost profile of the industry has flattened: for instance, 90 percent of costed production had a range of 39 c/lb in 1981, but only 22 c/lb in 1986; 75 percent had a range of 38 c/lb in 1981, but only 20 c/lb in

1986; and 50 percent of costed production had a range of 23 c/lb in 1981, but 15 percent in 1986. This flattening cost curve will mean an increase in price volatility, as we are now seeing, because price will have to fall further before production is curtailed and rise more before increased output is possible. Indeed, average costs in the 1981-86 period fell faster than prices, 37 percent versus 21 percent for London Metal Exchange (LME) prices. This resulted in a dramatic improvement in the industry's average profitability.

Of the western world copper-producing industry, 56 percent operated profitably on a cash basis in 1981, but this rose to a peak of 89 percent in 1985 and 85 percent in 1986. On an all-up costs basis, the percentage improved from 47 percent in 1981 to a peak of 70 percent in 1985 and 58 percent in 1986. The enormous changes in 1986 of fully-allocated costs compared with a relatively small change in cash costs shows the impact of mounting debt on the industry, partly because capital expenditure is being incurred to bring down unit costs.

Factors contributing to increased profitability against falling metal prices have been reductions in manning and labour rates, changes in exchange rates, over-mining and high grading, lower energy prices and lower treatment charges. Profitability has also been enhanced by closures in the high-cost sector and significant expansions to lower costs. Overall this period can also be characterized as one of trimming down corporate fat.

Aluminum

Western world cash operating costs have fallen from a peak of 55.2 c/lb in 1982 to an estimated 44.4 c/lb in 1986, a decline of 20 percent. All costs are cash operating costs, thus excluding interest and depreciation. This fall has been due not only to the closures of some high cost capacity, noteably in the USA and Japan, but also to reductions in the major cost elements of producing primary aluminum.

From the peak in 1982, the average cost of alumina to the smelters fell by some 25 percent to an estimated 14.9 c/lb in 1986 because of:

- lower bauxite prices;
- falling oil prices;
- improved energy efficiencies and productivity;
- the closure of old but inefficient capacity;
- building of new plants in Australia, Brazil, Venezuela, Ireland and Spain.

The cost of converting alumina to aluminum is dominated by the cost of power and the cost of labour supervision. Power costs fell by 11 percent to an estimated 11 c/lb in 1986, and by 15 percent since the peak of 1980, due to a fall in average western world power costs and to the commissioning of new, more energy-efficient plants, combined with the closure of elderly energy-inefficient smelters.

This latter phenomenon also changed the costs of labour supervision. Older smelters in the 150-180 thousand tonnes range required 16 to 18 man-hours per tonne of metal production, while the newest smelters require around 7 to 7.5 man-hours. Average labour costs thus fell from a peak of 9.7 c/lb to an estimated 8 c/lb in 1986. As one would expect, closures have occurred at the top end of the cost curve. A less recognized fact is that 90 percent of production remains in a similar cost range: 27 c/lb in 1980 and 25 c/lb in 1986.

Zinc

Since 1984 when costs were at their highest, average zinc costs in the western world on a fully allocated basis have fallen by 3.7 c/lb or 9 percent, to 37.4 c/lb, and cash costs have fallen by 4.1 c/lb to 34 c/lb in 1986. Thus, from 1984 to 1986, cash costs have fallen by 11 percent and prices by 20 percent; in other words, the profitability of the industry has deteriorated. Only 79 percent of the industry operated profitably in 1986 on a cash basis, compared to 95 percent in 1984. Since 1984, Australia, Canada, Mexico and South Africa have shown improvements in relative average costs, while the relative position in the cost curve of the European producers has deteriorated alarmingly in dollar terms, due partly to currency changes.

One way of looking at the profitability of the lead/zinc industry is to compare the cost of tonnes of ore milled with total revenue. Figure 2 suggests that a period similar to 1979-1980 will be needed if the industry is going to invest significantly in its future.

Average western world mine/mill costs per tonne of ore have fallen since 1984 by 10 percent, to $19.5 per tonne in 1986, despite the strength of the dollar, which has increased the costs of many operations in western Europe and Japan. Achievements in the USA were notable: a fall of 22 percent to $14.5 per tonne in 1986.

"Lower costs beget lower prices and higher costs beget higher prices" is a rule learned over the last ten years. In retrospect, the low metal prices seen in recent years should have come as no surprise in the context of surplus metal and declining costs.

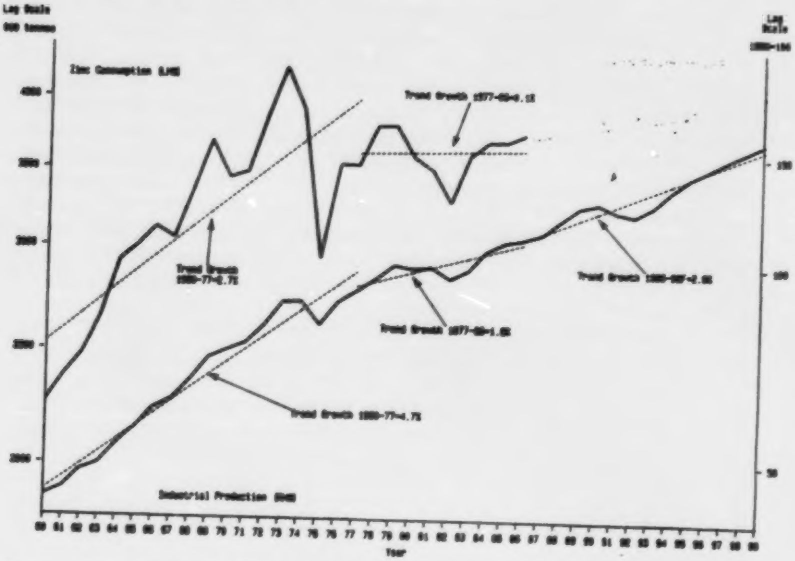

Figure 2. OECD Slab Zinc Consumption and Industrial Production

Limited Investment

The second factor concerning each metal has been the dearth of capital investment for new projects, partly because of the uncertain outlook and strained profitability, and partly because, until recently, surpluses seemed to be a way of life.

Copper

As shown in figure 3 for copper, capacity losses in the ten years to 1997 amount to just over 2 million tonnes, of which 1.4 million tonnes will come from mine closures with the balance from attrition due to declining ore reserves, grade, etc. Increased capacity, based on current projects which look as though they will go ahead, will amount to 2.3 million tonnes, of which 1.6 million tonnes will result from new projects and 0.7 million tonnes from incremental expansions.

In the last two years of the century, regrettably not shown in this figure, there should be a further loss of some 460,000 tonnes to capacity, to bring capacity to 6.7 million tonnes in 1999, some 100,000 tonnes lower than in 1986. However, with the current level of prices and the high rate of exploration for gold in the Pacific throwing up the possibility of discovering another major copper-gold porphery deposit, the danger is that more projects will come forward. Indeed, should copper and other metal prices continue at current levels or higher over the next 12-18 months, the financing of mining projects will become the flavour of the year. The important question for copper prices, however, is "How fast will demand grow?"

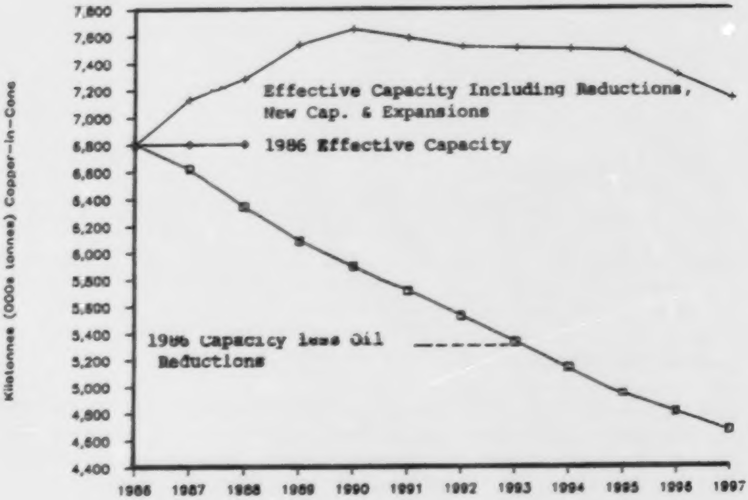

Figure 3. Effective 1986-97 Copper Mine Capacity

Aluminum

Smelter capacity in the western world should increase by 1.1 million tonnes from 14.2 million tonnes in 1986, to 15.3 million tonnes in 1999, based on current plans. New capacity will be added principally in:

- South America - 1 million tonnes;
- Canada - 650,000 tonnes;
- South Asia - 630,000 tonnes;
- Oceania - 450,000 tonnes.

Capacity will be lost in the USA (1.4 million tonnes) and western Europe (286,000 tonnes) although closures could be more extensive in the latter region. Furthermore, the downturn in world markets we foresee in 1990-92 will threaten the survivability of excessively debt-laden smelters.

The location of smelters is changing from the traditional areas of the three major consuming regions - United States, western Europe and Japan - to areas where energy is relatively cheap, such as Canada, Venezuela, Brazil, Australia and the Middle East. The aluminum industries of the three major regions are going through a period of change with the sourcing of primary aluminum for the technologically strengthened down-stream industries being concentrated on the low-cost domestic and off-shore smelters.

The change has been most dramatic in Japan, where the domestic smelter capacity has been reduced from 1.6 million tonnes per year (tpy) in 1979 to only 64,000 tpy by the beginning of the next year. To compensate for the loss of domestic smelter capacity, producers have made substantial investments over the past 20 years in regions with relatively low-energy costs, giving them an off-shore capacity base of some 800,000 tonnes.

In 1985, the USA embarked on a program to phase out capacity, initially the so-called "swing capacity" and ultimately some high cost base capacity. In the early 1990s, about 1.8 million tpy of the 1984/85 U.S. smelter capacity should have been permanently closed down.

A program to rationalize western Europe's primary aluminum industry has started with a series of modest closures in France, Spain, Switzerland and West Germany. By the early 1990s, nearly half a million tonnes of western Europe's 1986 capacity will have been phased out, partially offset by 269,000 tonnes of new capacity coming on stream over that period.

The predominant source of power, in the past and for the future, for all new smelters except those in Australia, is hydroelectric. Even a hydroelectric power source, however, does not guarantee absolute security of supply, as has been evident from the technical problems and climatic conditions seen in Brazil, Ghana and Indonesia.

Zinc

Mines are like people: they grow old - although some of us try to defy the laws of nature! - then get tired, and finally die. The degree of senility in the zinc industry (in the mines, not the people) is often underestimated.

In the 1987-99 period, mine closures should amount to a massive 1.3 million tonnes, with a further near 600,000 tonnes of production being lost for reasons including reserves and grade. In this period, just over 1 million tonnes of new mine capacity will be brought on stream. Incremental expansions will add a further 386,000 tonnes, unless prices rise sufficiently to encourage the development of new projects. This will mean that mine capacity will be some 500,000 tonnes lower in 1999 than in 1987, and indeed by 1990 it should be nearly 250,000 tonnes lower than this year. Thus, with the aging of existing capacity, more investment in new capacity will be needed.

Growth in Metal Consumption

The third factor common to all metals has been the growth in metal consumption since 1982. As shown in table 1, the fastest growth rate has been for nickel, closely followed by aluminum and zinc, with copper and lead consumption rising more modestly. Is this the trend of things to come? It is also pertinent to note that much of the strong demand for metals so far this year, and particularly in the USA, has been for downstream inventory replenishment, the result of a perception earlier this year that prices in the broad economy were likely to rise faster than they have recently.

"Long-range planning does not deal with future decisions, but with the future of present decisions", wrote U.S. management consultant Peter Drucker. The outlook for the next ten years is there for all of us to see if we research and analyze carefully the end-use markets and mine developments. New products, materials, new uses, technology, etc., are either in the laboratories, at the product development stage, or waiting to be promoted; and mine closures and projects are largely known.

The same is true in the macro-economic environment. The seeds of further market and business volatility, economic growth, inflation and recession are already in evidence, if we look at the world with open eyes and not with mirrors.

Table 1 Western World Metal Consumption 1982-1986 (thousands of tonnes)

	1982	1986	% Increase
Aluminum	10,803	13,102	21
Copper	6,967	7,589	12
Lead	3,795	4,114	8
Nickel	456	562	23
Zinc	4,151	4,934	19

Development of the World's Economy

We expect business activity to improve in the period to 1990, accompanied by rising inflation, followed by a recession in 1990-92, as the excesses of the recent past are wrung out of the system. Then, hopefully, and I stress hopefully, better long-term growth will follow. Thus western world industrial production is forecast to increase by 3.4 percent per year in the 1990s, compared with 2.1 percent per year in the last ten years and 5.5 percent per year in the previous fifteen years.

Markets, however, have sensed the decline of disinflation and the rise of inflation, despite the present relatively low level of inflation in the Organization for Economic Cooperation and Development (OECD). We believe that world inflation will rise sharply, perhaps reaching 22 percent in 1988 compared with the previous peak of 16 percent in 1985, based on the rise in world money supply which has already occurred.

The inflationary environment could deteriorate even more, unless moves are taken to sterilize the enormous supply of international dollars caused by the U.S. trade deficit, and by the U.S. banks resuming their lending abroad in the international interbank market last year. As a result, total foreign holdings of U.S. dollar assets rose by $213 billion in 1986 compared to $127 billion in 1985.

The forecast for oil prices is an average of $19.5/barrel, in 1987 dollars, in the 1990s, reaching $25 by the end of the decade (although they could be higher by then because of capacity limitations). In the near term, oil prices could fall to around $16-17 before rising again to $20 by the end of this year and averaging $18 in 1987 and $20 in 1988.

Despite the strength of private demand for dollar assets, which is starting to decline for other reasons, foreign central banks have had to purchase increasing amounts to keep the dollar from falling further. Last year their purchases totalled $53 billion, but in the first eight months of this year alone, they amounted to a huge $127 billion, somewhat larger than the U.S. trade deficit for the same eight-month period. Until America stops living beyond its means, the dollar will continue to fall as the ability and desire of overseas central banks to support the U.S. currency wanes and becomes restive.

Rising inflation will spread to nearly all countries. First to be hit in the developed world will be the USA, where the rise in inflation will be brought about by:

- the lagged effects of high money supply growth in 1985 and 1986;
- the sharp fall in the value of the dollar;
- continued fiscal laxity;
- probable wage increases.

The prospect of rising prices will change the habits of manufacturers and consumers. Inventories will rise at all levels, and the self-feeding cycle of demand chasing prices will resurface after eight years, as it has started to do in the USA.

In summary, the macro-economic environment should support better metal demand and higher prices in the period to 1990, followed by two to three years of declining consumption and prices, then followed by higher demand.

Metal Consumption

Let us now look at consumption, against a background of industrial production rising by 3.1 percent a year in the OECD and 3.7 percent in the lesser developed countries (LDCs) in the 1990s.

Copper

Unless current trends are arrested by producer action, copper's decline in intensity of use will continue. Main causes are as follows.

- Fibre optics are replacing copper in telephone trunk-lines and starting to do so in the feeder network between telephone exchanges. By 1992 copper will start to be replaced in the subscriber loop network, which accounts for 65 percent of copper's use in telephone cables.

- New aluminum alloys are penetrating the market for wiring in non-residential construction.
- Gauge reduction is occurring in wiring cables for automotive uses and domestic appliances and may occur in some house wiring applications.
- In magnet wire over the last five years there has been a 25-percent decline in copper consumption due to gauge reductions. The wide use of energy-efficient motors in domestic appliances, coupled with the use of permanent magnets in automotive starter motors, will reduce overall demand for copper in these two sectors by 40 percent over the next five years.
- There is a growing trend to use multiplexing and fibre optics in automotive wiring in the 1990s.
- More plastic tubes will be used in the construction industry (except for domestic plumbing, which nevertheless remains threatened).
- By 1999, virtually all new automotive radiators will be aluminum, and ceramic engines which require no radiators will be in general use.[1] Aluminum will be used widely in the after market in the mid-1990s. This development will occur despite the rear-guard action mounted by the copper industry.
- The general trend to micro-miniaturization helped by computer-aided design, the use of new composite and ceramic materials and near-net-shape manufacturing techniques, will generally reduce the amount of copper used in a wide range of products.

Significant changes will occur to the pattern of copper consumption. The LDCs as a group will be the sole source of substantial growth in consumption between now and the end of the century. Consumption in this region should rise by 49 percent in the 1990s, compared with 50 percent in the last decade. During this time, consumption in the USA rose by only 1.2 percent, and is expected to rise by 4.5

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1. For another view of the future of the ceramic engine see the digest of discussions (ed.).

percent in the 1990s, while in Japan consumption is expected to fall by 2.0 percent compared with a growth of 10.5 percent in the ten years to 1986. Growth in western Europe will be 4 percent.

In the USA, Japan and western Europe, which consume 82 percent of the western world's copper, there has been some change in the use of copper by industry, and this will become more pronounced. Change has been significant in the transport industry, with consumption falling by 17 percent in the last ten years and expected to decline by 39 percent by 1999. Copper use in general engineering applications has risen by nearly 16 percent in the last ten years, and is expected to rise again by 16 percent by 1999. Its use in the construction industry will expand, unless the fear that plastics will significantly penetrate the market for domestic tubing becomes a reality.

Total wire and cable consumption has remained unchanged in the last ten years, with decreases in power and telecommunication cable uses matched by increases in wiring and magnet wires. Total consumption is expected to fall by 6 percent over the next ten years, mainly because of a 52-percent decline in telecommunication cables. However, the use of thinner gauges, permanent magnets in auto starter motors, multiplexing in auto harness, and penetration by aluminum in non-residential construction will reduce the amount of copper used.

Copper consumption is forecast to increase by some 800,000 tonnes by 1999, of which some 550,000 tonnes will come from the LDCs. Its growth rate should be 0.6 percent in the 1986-99 period and 1.4 percent a year in the 1990s.

Aluminum

Primary aluminum consumption should increase by 1.3 percent in the 1986-99 period and by 2 percent a year in the western world in the 1990s, compared with 1.1 percent in the last ten years and 5 percent a year in the previous decade, 1977-86. This will mean that the consumption of primary aluminum in the western world should increase by 2.5 million tonnes from the end of 1986 to 1999. Aluminum consumption grew massively in the sixties and early seventies because of the industry's earlier research and development effort. There is now a renaissance of that much-needed effort by some companies.

The decline in intensity of use is occurring because of increasing competition from various forms of plastic, composites, fibres and other metals. In addition, the general trend to microminiaturization, thinner gauges, and better manufacturing techniques is reducing the quantity of metal used per product.

The change in the pattern of consumption evident in the last ten years will continue. Growth will be fastest in the LDCs, while western Europe and the USA will continue to lose world market share to these countries. In the 1990s, primary consumption in the LDCs should increase by 41 percent (compared with 80 percent in the last ten years), by 18 percent in Japan, 9 percent in western Europe and 5 percent in the USA. This will result in western world consumption growing by 13 percent or 1.8 million tonnes compared with 15 percent, or 1.7 million tonnes in the 1977-86 decade.

In western Europe, Japan and the USA, which together use 80 percent of the western world's aluminum, growth has been by far the fastest in containers and packaging, with consumption increasing by 58 percent in the 1977-86 decade. Use of aluminum in the transport industry grew by 34 percent, as it did for machinery and equipment. In the 1990s growth in containers and packaging will be slower because gauge will be reduced by another 20 percent and because of competition from plastic containers. Relative to the average, transport will be a growth market with increased use of aluminum cast parts such as radiators in the automobile.

In summary, as shown in figure 4, primary aluminum consumption should grow by 1.6 percent a year compared, to an increase in industrial production of 3.1 percent a year in the 1990s in the OECD. In the LDCs, aluminum consumption should rise by 3.9 percent a year against industrial production, increasing by 3.7 percent a year in the 1990s.

Zinc

Western world slab zinc consumption, graphed in figure 5, is forecast to grow by 1.5 percent in the 1986-99 period and by 2.2 percent a year in the 1990s compared with an annual growth rate of 1.7 percent in the 1975-86 period and 3.8 percent a year in the prior decade.

In the OECD, intensity of use will continue to decline, due mainly to:

- the general trend to using improved design techniques that require less metal per unit;

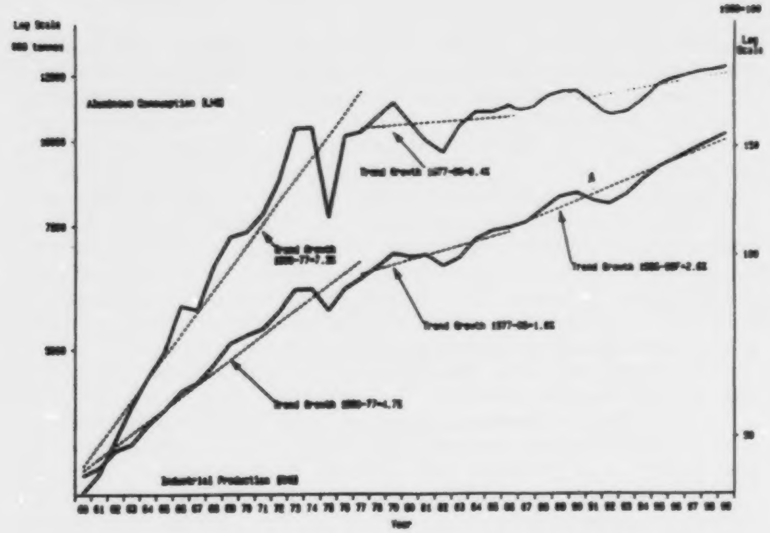

Figure 4. OECD Primary Aluminum Consumption and Industrial Production

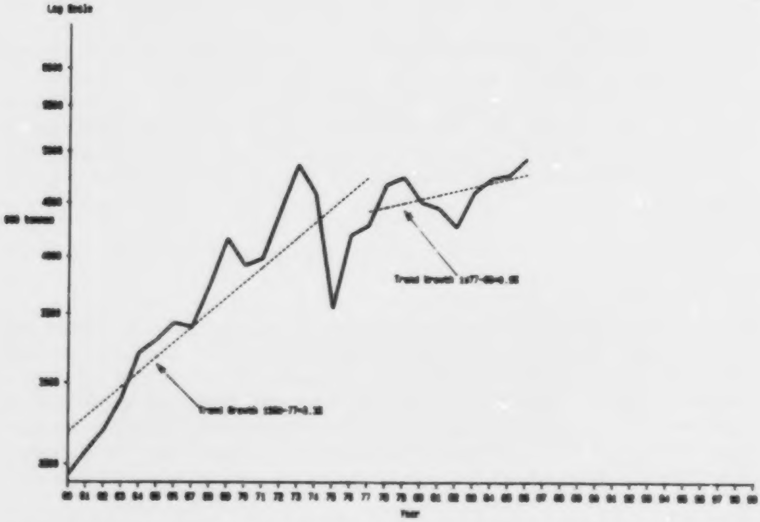

Figure 5. World Slab Zinc Consumption

the continuous new use of other materials such as aluminum, plastics and composites;
- the increasing use of thinner-walled diecasting and of electrogalvanizing;
- in the mid-1990s, the replacement of steel by plastics in automobile panels - assumed to be 20 percent in the USA and Japan and 10 percent in western Europe.

Significant changes will continue in the pattern of consumption. Growth will be strongest in the LDCs, rising by 3.9 percent a year in the 1986-99 period compared with a growth rate of 0.6 percent in the OECD. As a percentage of total western world consumption, the LDCs' share has increased from 16 percent in 1975 to 23 percent in 1986 and is forecast to rise to 32 percent in 1999. Interestingly, Japan's consumption was the same as the LDCs as a group in 1977, but is now significantly lower. Japan's share of the total has fallen from 17 percent in 1977, to 15 percent in 1986 and should fall to 14 percent in 1999. In western Europe, while consumption has risen by nearly 400,000 tonnes since 1975, its share of the total was almost unchanged at 35 percent in 1986, but is expected to fall to 31 percent in 1999.

In western Europe, Japan and the USA, which together consume 70 percent of the western world's zinc, the pattern of consumption by industry will not alter significantly. Zinc consumption in diecasting will continue to fall, but will accelerate in galvanizing, rolled and extruded products and brass semi-fabricated products. Thus growth of slab zinc consumption in the OECD, graphed in figure 6, is likely to rise by 0.6 percent in the 1986-99 period and by 1.2 percent a year in the 1990s.

In the LDCs, zinc consumption should rise by 3.4 percent per year in the 1986-99 period and by 4.6 percent in the 1990s. The increase will be due mostly to the use of galvanizing in plant and non-residential construction, the expansion of the automobile industry and general increases connected with an expanding industrial base.

Conclusion

Over time, it is the level of demand that determines price. All metals face increasing competition not only from newer materials but also from new technology. The stimulation of consumption by research, product development and promotion is a prerequisite to building a healthy and prosperous industry. The least that the major and mature metals

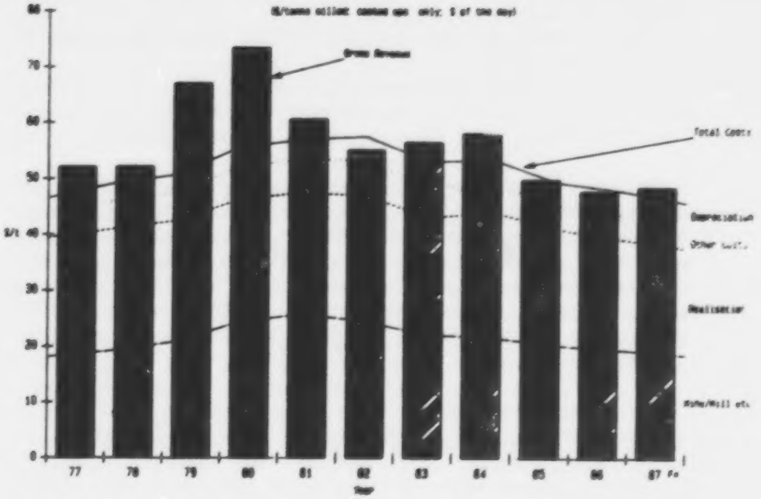

Figure 6. Unit Cost Breakdown vs Gross Revenue

should do in this regard is to match the marketing efforts of the newer materials.

Aluminum is a good example. Its approach in the 1950s and 1960s was strongly market driven. The industry seemed to live off that work for a number of years, and now there seems to be an encouraging renaissance of that effort. With zinc, even though the industry has also put considerable effort into R&D with some gratifying results, more could be done.

In the copper industry, however, efforts are minimal and important end-use markets like DWS tube and house wiring may be lost in the next decade to plastics and aluminum respectively. For copper the long-term outlook for prices cannot be encouraging until the industry throws off the image of copper as a 19th-century metal and sets about promoting itself, defending its markets and developing new products in a logically conceived world plan.

After this current cycle dies in a classic orgy of excess sometime in 1989-90, surpluses will reappear and will last well into the second half of the 1990s. Copper prices will remain weak, but, based on our trend forecasts for costs, not inconsistent with the margin between price and cash costs evident in the 1980s. Copper prices should average only 52-55 c/lb in the 1990s, reaching 60-65 c/lb by the end of the decade, all in 1987 money.

Aluminum, on the other hand, has the prospect of earlier capacity shortages in the 1990s. Before considering the future of aluminum prices, however, the underlying trends in future costs need to be analyzed carefully. Average operating costs are forecast to rise by some 11 percent to 51.1 c/lb in constant 1987 dollars in the period to 1999.

The cost of converting alumina to aluminum is forecast to rise by some 13.5 percent over 13 years to 17.5 c/lb in 1999. Price increases will be limited, due to the development of the Los Pijignaos mine in Venezuela, the expansion of operations at Trombetas in Brazil, and the fact that in Guinea bauxite prices will remain depressed for all producers in real terms, with host governments having to make the biggest revenue concessions.

Furthermore, bauxite conversion costs will be contained by improvements in energy consumption such as the retrofitting of older refineries with new calcining equipment and a switch to coal with substantial rises in oil prices. Incremental expansions to the capacity of new alumina refineries will also help to steady average costs.

An important and the least predictable underlying factor to future costs is the cost of power. Nearly 20 percent of production capacity is now tied to power sources linking power prices to the aluminum market in some manner. A further 25 percent of production capacity is supplied from company-owned facilities, leaving some 55 percent of production capacity supplied from sources where power pricing may be determined by factors not directly related to the commercial aluminum market (such as subsidized power rates to maintain employment or to preserve a strategically important industry). Conversely, the demands made on a utility by other regional requirements may dictate that power costs be fixed at an "unattractive" level. On balance, we think the cost of power expressed in cents per lb of metal over the 1987-99 period, will increase in real terms by around 20 percent with the USA seeing the biggest increases.

Prices in the late 1990s may be higher than our forecasts because of capacity shortage, but over time a 65-c/lb average price in 1987 U.S. dollars, which we forecast for the late 1990s, is one that the market can accommodate. Despite an expected recession in 1990-92, resulting in the cash price falling to an average of 47 c/lb in 1991, the cash LME price for 99.5 percent grade material is forecast to average 60 c/lb in the 1990s, again in constant 1987 money.

The zinc industry is in transition, moving from surplus concentrate-producing capacity and surplus metal-making capacity to shortages of both. Prices will rise at some point to encourage that capacity to be developed. But zinc is particularly sensitive to high prices in its end-use markets and, while price increases to the 50-c/lb and over range should not be surprising by 1990, significant falls will then occur brought by diminishing demand. In our view a price averaging 38-42 c/lb for the 1990s is likely, punctuated with short periods of up to 50-55 c/lb and down to 30 c/lb or lower, all in 1987 money.

Thus, with paralysis in Washington, an innate desire to see continued economic growth in the USA in 1988, and with the world expansion of credit that has already taken place, "Déjà vu, or 1978-1980 Revisited" may not be so far fetched, not forgetting 1982.

PROSPECTS FOR THE CANADIAN MINERAL ENDOWMENT

Jan Zwartendyk

Introduction

In the context of the world supply-demand patterns emerging for the 1990s, what does Canadian mineral endowment have to offer? Will constraints to vigorous Canadian mine production be primarily in the realms of marketing and trade? What about constraints posed for the 1990s by the limits of Canada's mineral endowment, and by our sketchy knowledge of that endowment?

Following a clarification of the concept of endowment, these questions will be pursued in the light of the shift of interest from base metals to gold.

The Concept of Endowment

Many people would be hard put to explain how mineral "endowment" differs from mineral resources. Mineral endowment is one of those fine terms, along with mineral patrimony, mineral heritage and mineral wealth, that have a comfortable ring to them and are convenient where vagueness is useful. In the more circumscribed meaning given by those active in resource assessment, mineral endowment refers to certain modes of occurrence of an element (for example, as in sulphide form) with a specified minimum grade, a minimum tonnage, and down to a maximum depth. In a generalized way, these limits express the boundaries of our economic interests and technological capabilities. Endowment is a handy concept for a geologist who hates being confronted with the need for economic judgments and prefers to stick to describing what is in the ground within limiting requirements of grade, tonnage and depth.

Bounded by such limiting requirements, the mineral endowment of an area is fixed. It is a measure of the physical scarcity of mineral deposits, with a positive sound to it.

"Resources" are more focused, referring to those mineral concentrations within the endowment from which mankind is likely to draw mineral supplies in the foreseeable future. Resources are thus limited not only by what the natural mineral endowment has to offer, but also by the opportunities seen in the uses of that endowment. That introduces considerations of, for example, discovery, recovery and access - all of which carry price tags.

The knowledge we have acquired of our endowment, always at a cost, is biased by the practicalities of economic interest. That interest focuses on resources, not on inventorying the mineral kingdom for its own sake. We are willing to pay for knowledge only according to its hoped-for usefulness. Therefore, while knowledge of our resources is scarce, we know even less about our endowment.

How Large Is Canada's Mineral Endowment?

As most of our endowment is unknown, we may obtain an impression of its size only indirectly. For example, it is obvious that mining gradually depletes the endowment. The size of the endowment will determine how long it will take for the effects of depletion by mining to become noticeable. The rate of decline of ore grades mined over several decades might give an indication of the rate of progressing depletion of the endowment on a national scale. Another clue might be found in discovery costs. An increasing difficulty in the discovery of new deposits might suggest how seriously the initial endowment has been diminished by our mining activities.

Conventional wisdom holds that, as a consequence of gradual depletion of the best deposits, ore grades have declined and the costs of finding new minable deposits have risen in Canada. But recent investigations of these two variables have failed on either count to find evidence supporting this prevailing wisdom.

Ore Grades Mined in Canada Since 1939

The notion that ore grades mined have declined seems to be rooted mainly in the observation, widely repeated in the literature, that the average copper grade mined in the USA has dropped from more than 3.0 percent in 1900 to about 0.5 percent in recent times; but the meaning of that change is not as evident as it seems. This decline of the average grade reflects the human choice to start mining extensive low-grade porphyry deposits by large-scale, low-cost methods. Economists view this as textbook evidence of progressing technology countering the rising costs associated with depletion. In other words, as we started to run out of higher grades, technology came to the rescue enabling us to mine lower grades without a rise in cost.

But is it realistic to take for granted that resource depletion was the driving force behind the opening up of low-grade porphyry mines? The study performed by Martin and Jen[1] suggests not, at least not in Canada. It is evident that large-scale open-pit mining of copper porphyry orebodies in Canada since 1960 offered an economic alternative to the much more expensive underground mining of higher grade non-porphyry copper deposits. But this development took place alongside the mining of non-porphyry copper deposits and not its replacement. The average mining grade of non-porphyry copper deposits has shown remarkable steadiness from 1939 to today, even though production from such deposits rose at the same time the porphyries came on stream.

The average mining grades of nickel, zinc and gold ores have shown a similar steadiness (figure 1). Where grades have shown a decline, these declines can be attributed to directly observable reasons which are more plausible than the depletion of all higher-grade resources in Canada.

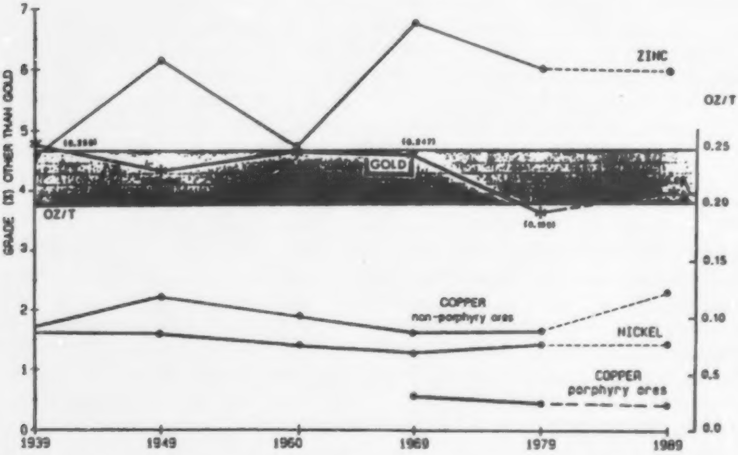

Figure 1. Grades in Ores Treated

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[1] H.L. Martin and L.S. Jen, "Are Ore Grades Declining? The Canadian Experience, 1939-1989", World Mineral Exploration: Trends and Economic Issues, J.E. Tilton, R.G. Eggert, and H.H. Landsberg, eds., Washington D.C., Resources for the Future, 1988.

These observations suggest that the effects of depletion of the Canadian endowment in general have so far been hardly noticeable. Technological advances allowing lower grades in different deposit types to be mined profitably were apparently not inspired by the threat of depletion of higher-grade deposits.

We are led to conclude, on the basis of the long-term record on ore grades mined, that depletion of the Canadian endowment has been much slower than is commonly assumed The endowment is larger than is generally thought, which is good news for the 1990s and beyond.

Discovery Costs in Canada Since 1946

In a comprehensive study of the cost of discovering approximately 900 deposits of metallic minerals in Canada since the World War II, Cranstone[2] failed to find any convincing evidence of a consistent rise in real discovery costs. (Throughout this paper, a "discovery" is taken to be a deposit sufficiently attractive to have warranted the expenditure necessary to establish its tonnage and grade.)

Canadian mineral exploration experienced a period of outstanding success in the mid-1950s, the explosive result of the first application of modern exploration methods. Subsequent to that peak, the value (metal content multiplied by metal prices) of metals discovered per dollar of exploration expenditure remained fairly steady up to 1978, a period of more than twenty years of growing exploration activity.

Since 1978, discovery values per exploration dollar have been lower, although the average number of metal deposits discovered each year in the 1978-85 period, which represents 32 deposits, was higher than the historical average of 24.

Brian Mackenzie,[3] in a 1985 study, followed a route of inquiry different from Cranstone's, but came to a similar conclusion, namely that "the available evidence does not support the contention that the quality of Canada's base metal resources has deteriorated with time".[4]

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2. D.A. Cranstone, "The Canadian Mineral Discovery Experience Since World War II", in World Mineral Exploration: Trends and Economic Issues.
3. B.W. Mackenzie, Geological Aspects of Mining Productivity: Canada Base Metal Resources, Technical Paper No. 6, Centre for Resource Studies, Queen's University, Kingston, Ontario, 1985, 103 p.
4. D.A. Cranstone, "The History of Gold Discoveries in Canada - an Unfinished Story", CIM Bulletin, October 1985, p. 59-65.

A reasonable conclusion on the basis of the long-term record on discovery costs is that the steadiness of these costs up to the late 1970s suggests that exploration has been sampling a large endowment, and that it would be premature to consider the lower values found per dollar since 1978 as clear evidence of a permanent trend caused by depletion of the endowment.

The Role of the Major Deposits

The total gross values of metals contained in the largest and smallest Canadian mines differ by a factor of at least 3000. It should, therefore, not come as a surprise that the largest-tonnage discoveries - not necessarily the highest-grade ones - have dominated subsequent production: the 40 largest metal-bearing deposits among the more than 900 discovered since 1946 account for about half of the total gross metal value.

The relatively high number of discoveries in the 1978-85 period without a commensurate rise in their total value reflects a decline in their average size. This is a point of interest: is it a sign that major deposits in the endowment are becoming noticeably scarcer?

The dictates of economics require large deposits to be mined before small ones, the rich before the lean, and the easily accessible before those in remote regions. This applies to known deposits, but not to the endowment as a whole. Our knowledge of the total endowment is only sketchy; if we knew the location of all the largest and richest deposits, we would no doubt mine them first. But we do not, and experience shows that they are not necessarily the easiest to find or to recognize as minable deposits. In some cases, new developments in mining technology open geological eyes in new directions, as in the case of porphyry deposits. Moreover, the dynamics of technology may over time shift our judgment about which deposits are the "best".

Relatively recent discoveries of some major deposits, for example of gold at Hemlo and of uranium at Cigar Lake (with a grade 100 times that of ore currently mined at Elliot Lake), are only the latest evidence that the endowment does not yield its secrets in any orderly sequence of size or grade.

It is therefore of special interest to track the patterns of past major discoveries to see what they might reveal. Highlights from two recent studies help to provide some long-view perspectives - one on gold, the other on base metals.

The Potential for Major New Gold Discoveries

A history of gold discoveries in Canada from 1823 to 1983[5] shows the following:

- more gold was discovered during 1973-82, the last decade covered by the study, than during any previous decade. Hemlo accounts for one third of that amount;
- all major gold deposits (containing more than one million ounces) discovered to date represent three times as much gold as all the smaller ones together;
- in the historical context, the number of discoveries during the last decade of such major gold deposits was high (figure 2, and a recent update raises the 1973-82 total from 12 to 19);
- Hemlo vies with the "Golden Mile" at Kirkland Lake for second place among the largest single deposits of gold ore known in Canada;
- Hemlo is not so enormous that Canada is unlikely to see another such deposit again;
- gold grades mined are comparable with those mined decades ago, despite much higher recent prices;
- vast areas of the country have never been subjected to a determined, systematic search for gold.

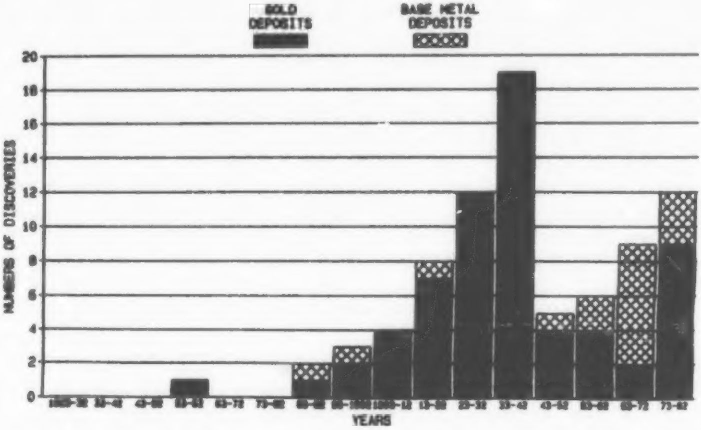

Figure 2. Numbers of Discoveries Containing More Than 1 Million Ounces of Gold

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[5] Ibid.

It may be concluded that the Canadian mineral endowment is likely to contain many major golden plums and, if the discovery of Hemlo on the Trans-Canada Highway is any indication, they are not necessarily all in the far North.

The Potential for Major New Base-Metal Discoveries in Canada

The history of discoveries of major base metal deposits requires more courage to extrapolate (figure 3). The record since 1945 shows that about 75 major deposits (worth more than $1 billion in contained metal) of nickel, copper, zinc or lead have been found in Canada, an average of almost two per year. However, the last major discovery, the HW deposit of Westmin Resources, was in 1979. A lean period of unprecedented length followed. The swing of exploration funds toward gold may be part of the explanation - as may be plain bad luck. Also, in the 1980s unusually weak base metal prices have made for conservative exploration, carried out close to existing mining camps.

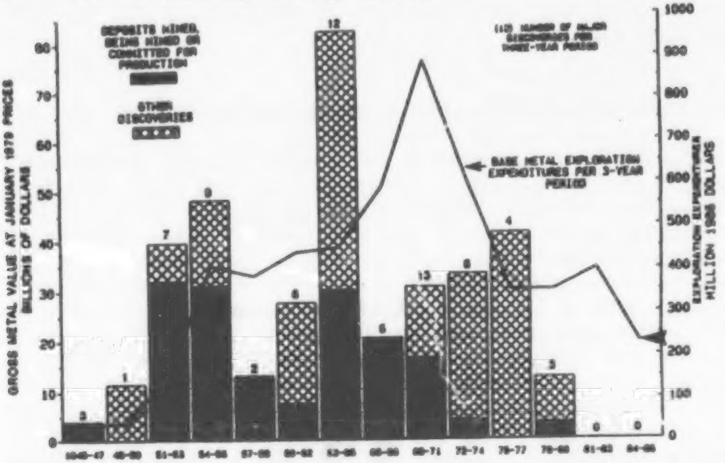

Figure 3. Numbers and Values of Major Discoveries Since 1945 Containing More than $1 Billion Worth of Copper, Nickel, Zinc or Lead, and Exploration Expenditures

Can we place some of the blame on endowment limitations? The clues we have at hand give us mixed signals. We saw earlier (figure 1) that the average base metal grades mined in Canada have not fallen, suggesting no pressures from overall depletion. We also noted that the long-term trend in value of discoveries (of all minerals together) per exploration dollar has been fairly steady since the mid-1950s, at least up to 1978. In this overall value of discoveries, however, the lack of major finds of base metals would be largely masked by major successes in uranium and gold.

Of course, low base metal prices have set higher requirements on what can be mined profitably. Of the base metal endowment (deposits of at least a certain grade and size, and down to a limiting depth), a smaller portion is now considered to have economic promise than was the case ten or more years ago. In that sense, the target has shrunk, but has it shrunk enough to present a serious constraint for the 1990s? Many areas of Canada have not yet been extensively explored for base metals, and our exploration techniques hardly give us a clean sweep, even of the top 100 metres. It is, therefore, hard to believe that no major deposits remain to be found. Still, the bleak discovery record for base metals in recent years suggests it is time to give luck more support by sharpening our exploration techniques.

The Shift of Attention from Base Metals to Gold

The upswing in exploration for gold has been spectacular. In 1977-85, it has grown almost twenty-fold from less than $14 million to $260 million (both in 1985 dollars). This represents a rise from 7 to 65 percent of total mineral exploration expenditures. As a result, gold deposits constitute the bulk of the deposits recently discovered, of those brought into production and of those committed for production. Gold reserves rose by 70 percent in 1981-86.

We are now in the 135th year since the first discovery of lode gold in Canada, and it looks possible that, about half a century after its 1941 peak in gold production of 150 tonnes, Canada will reach that peak again and surpass it. The endowment has been sitting there relatively undisturbed all the while and presents no worries for gold in the 1990s.

In contrast, exploration for base metals declined from $90 million in 1977 to $70 million in 1985 (ignoring a short-lived speculative peak in 1980-81). As a percentage of total mineral exploration expenditures, the drop was from 44 to 18 percent.

As long as exploration for base metals continues, statistically, some large discoveries are likely sooner or later. Our capital of knowledge of what is in the ground is running down. Many mines have delayed the expense of delineating further ore to replace the base metals mined. Some former ore reserves were written off as unprofitable to mine at foreseeable prices. On balance, ore reserves of zinc and lead dropped by 20 percent in 1981-86, and those of copper and nickel by 15 percent.

The value of these major base metals produced in Canada in 1986 was still 2.5 times the value of gold produced: gold production was $1.7 billion, copper $1.6 billion, zinc $1.3 billion, nickel $1.1 billion and lead $0.2 billion. Productivity improvements have led to levels of base metal production in 1986 exceeding those of 1981, but, without some sizable new discoveries, the current production levels of copper, zinc and lead cannot be maintained much beyond the mid-1990s. A moderate rise in prices, even if it holds, will not significantly change the situation. As it takes an average of six years from discovery to production, the discoveries would have to come in the next few years.

Conclusions

Looking ahead toward mining in Canada in the 1990s, we asked ourselves a double question. What constraints will be posed to continued vigorous mine production by (1) the limits of Canada's mineral endowment, and (2) the inadequacy of our knowledge of that endowment? We confined ourselves to considering gold and the major base metals.

As to the first part of our question, such evidence as we have suggests that the size of the Canadian mineral endowment need not pose a constraint to mineral production in the 1990s, because it appears to be very large relative to the dent that mining has made in it to date.

As to the second part - the adequacy of our current knowledge of the endowment - enough knowledge is at hand about nickel in the ground. Also, gold exploration in the last few years has been so brisk that a flurry of new discoveries will boost national gold production considerably and keep it high through the 1990s, given a gold price above, for example, U.S. $250 per ounce.

We have, however, less reason to be sanguine about copper, zinc and lead. Our store of knowledge about our endowment of these base metals is wearing thin. It takes time to make a discovery, with an additional six years required on average to translate a discovery into a mine.

Without some major exploration successes - that is, more and better exploration and more luck - the current levels of national production of these metals cannot be maintained much beyond the mid-1990s.

CHALLENGES TO CANADA'S MINING INDUSTRY: A PERSONAL PROSPECTIVE[1]

Pierre Perron

Introduction

Canada's mining industry is facing many challenges in today's increasingly sophisticated society. But before studying these challenges, we should first take a look at Canada's new mineral and metal policy. This comprehensive statement on the federal government's perspective on mining, released in May 1987 by Mr. Merrithew, Minister of Energy, Mines and Resources (EMR), is not meant to be a blueprint for federal actions in the minerals and metals sector. Indeed, we specifically rejected such an approach. Instead, it is a framework through which future policies and programs can help the industry develop. Those who have recently asked that this policy statement be fleshed out will probably be disappointed, for it is meant to indicate to participants, provincial governments, industry and labour, what can and cannot be expected of the federal government. Finally, its intent is to ensure that everyone at the federal level, regardless of department or agency, is singing from the same songbook.

It is in the perspective of this new policy statement on minerals and metals that I intend to give you my own perception of Canada's future as a mineral producer. I should stress that this paper presents my personal views on where the industry is headed and the issues that will become important.

Mining in a Sophisticated Society

Mining is a tough business, but all business is tough. Even if mining has been around for a long time, it still has to find its place in a fast-changing economy. To flourish, the industry must adapt. This is certainly the lesson we all learned during the recession of the early 1980s. As an executive of a major producer of minerals and metals told me recently, having now survived the crisis, he felt entitled to become bolder when it came to new initiatives. But we certainly should not lose sight of the fact that profits are ultimately what drives the industry. Everyone benefits from a healthy and profitable industry - investors, businessmen, workers and government alike. If a loss of profitability can be endured for a short while, even more so if such a loss follows a long spell of good economic performance, it remains a *sine qua non* condition to stay in business. And this requires competitive rates of return.

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[1] The contributions of Mr. Robert Dunlop and of The Mineral Policy Sector of Energy, Mines and Resources are gratefully acknowledged.

Unless mining is up there in terms of attractiveness, the industry will wither and die. Figure 1 illustrates the nose-dive mining profits have taken since 1980. This means the adaptation is far from over. Hopefully, 1987's higher prices for base and precious metals will translate into healthier profit figures. This, unfortunately, is not the case for all commodities.

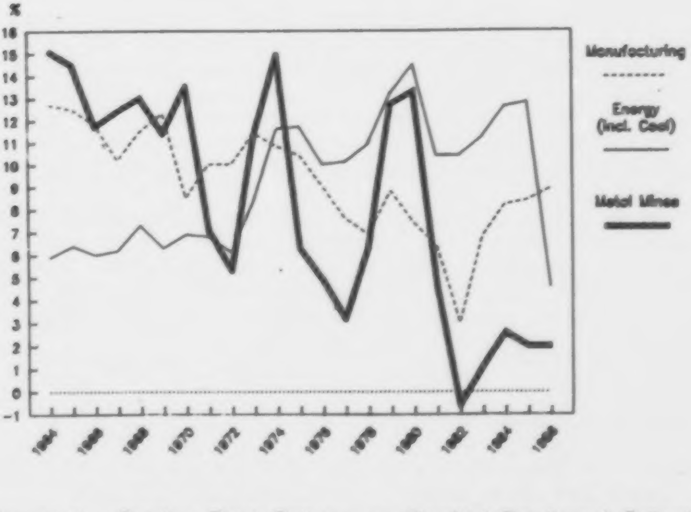

Figure 1. Pretax Real Return on Capital Employed Selected Canadian Economic Sectors 1964-1986

I predicted in the early phase of the last recession that industry would get back to where it should be, first by rationalizing its operations and by increasing its productivity, and that internal rationalization would later be followed by regional, sectoral and eventually international rationalization of assets. I believe I made my modest contribution to the latter type of rationalization in my native province of Quebec, in both the iron ore and the asbestos sectors.

From my perspective, the key to this adaptation is reaching a *modus vivendi* with society at large. That is, learning how to thrive in what has become a very sophisticated society, by building cohesive relationships with all sectors of society and deriving benefits from those relationships.

We are all realizing society is just too complex and interdependent for any segment, be it government, industry, labour, or other, to "go it alone". Each has a role to play, but little can be achieved without, at the very least, the non-opposition of the others. Of course, cooperation is the real goal and this takes work, time, effort and the will to understand other points of view, from all parties. As I often say, successful companies these days appear to be those that rally the interest of investors, managers, workers, and government at all levels. If the support of one segment of society is missing, the overall efficiency and profitability suffer.

Where Will Mining Fit Into The Economy?

One of the ways in which our society is becoming more sophisticated is through a changing economy. Some sectors are growing, and will continue to grow, faster than others. For example, services will probably grow faster than mining and other basic industries - a natural and inevitable evolutionary trend. This is not bad in itself, but it does change the power relationships in our society, something to which we all must adapt.

There is much trendy literature written about the "underlying forces" driving our economy. There is, however, a simple truth: as a society becomes richer, the kind of demands made change. For example, in a very underdeveloped country, virtually all that is demanded of its economy is food. As the society's wealth increases, demands for other goods grow relatively more quickly. Thus, while the absolute amount of food consumed may rise, the relative importance of agriculture to the economy declines. As a society continues to develop, the demand for material goods such as housing, cars, and other consumer goods grows exponentially. A stage is reached, however, as is the case now in the developed world, where the prospect of a third television or a second car is less exciting than that of a vacation or a really good meal in a restaurant. Many of those connected with industry, labour or government, however, seem to have trouble accepting this transition.

There is something substantial and comforting about an economy anchored by a rapidly expanding output of steel and zinc. Dry cleaning and tourism, on the other hand, may not inspire the same confidence, but these are the demands of a rich society. Does it make sense to try to produce more steel when people want vacations? Services are as "real" as any other economic activity, and will continue to be a growing proportion of our economy in the coming years.

What does this mean for mining? The absolute size of the sector may continue to grow, but will decline relative to the economy as a whole. As shown in figure 2, this has certainly been the pattern in the recent past. As a result, mining will have declining economic and political clout. Even though there will always be a voice for mining and a constituency, especially at the regional level, this voice will experience increasing difficulty being heard among all the other competing interests on the national stage.

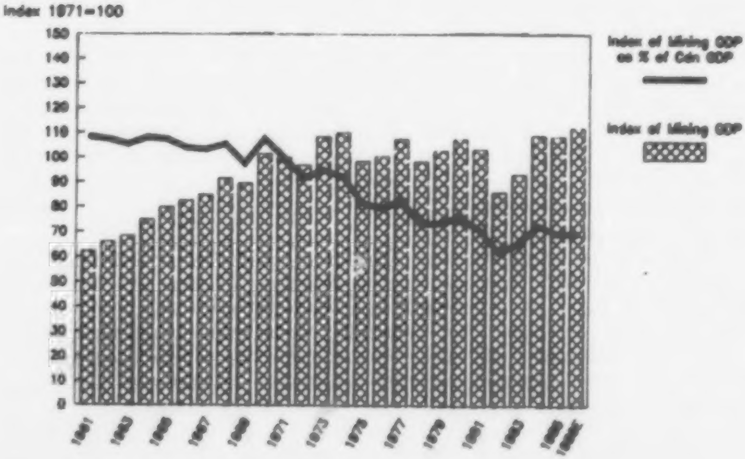

Figure 2. Canadian Minerals and Metals Industry Gross Domestic Product

This is important because we are becoming a more "political" society. As the interdependence between different sectors of society grows, so do opportunities for conflict. For example, there are those who want to mine uranium and those who fear the nuclear industry or who believe Canada should not produce uranium which could eventually end up in weapons. There are also conflicts between mining and the fishing industry. Many such conflicts which can be solved only at the political level are with us now, and the future will bring many more.

As time passes mining will have less clout to deal with these situations, fewer cards to play. The future, however, is not necessarily bleak; the industry simply has to play its hand ever more skillfully and, perhaps, in a more select way. In concrete terms this means two things: first, learning to use all the available advantages in the most efficient manner possible, and second, playing the political game at all levels with skill and maturity.

The mining industry has made great strides in these regards especially in the way it has dealt with the pressure for internal rationalization and is dealing with environmental issues. These examples show how mining can succeed in the future, how it can prosper in an increasingly sophisticated society.

Rationalization Within the Mining Sector

The industry faces pressure to maintain a steady increase in the rate of productivity. This fits into my theme of mining in a sophisticated society. One of the characteristics of a developed society is an expensive - but educated, articulate and productive work force. The reality in mining is that much of the competition comes from countries where wages are a fraction of what is paid here. Canadian mines will never match the wages paid by our Third World competitors (nor should they try).

Our competitiveness must come from the productivity of those employed in mining, a sector that in Canada will never be a labour-intensive employer. The pressures to increase productivity will keep direct employment levels at a modest level, even if output continues to expand. In fact, I would begin to worry about the ability of the sector to remain competitive if employment levels began to grow sharply. This also ties in with the difficulty mining will have in maintaining its political clout as long as creation of employment remains a political goal.

Figure 3, which shows trends in Canadian mining productivity between 1961 and 1986, presents three fairly distinct periods. The first, between 1961 and 1973, was one of steady mining productivity, growing output and fairly robust profitability. The second period, between 1973 and 1981, was one of weakening productivity, stagnant output and marked booms and busts. This was the period of high inflation and fears of commodity shortages during which mining was thought to be losing its competitive edge. Good prices and some good grades were confused with good mining. We all know what happened next.

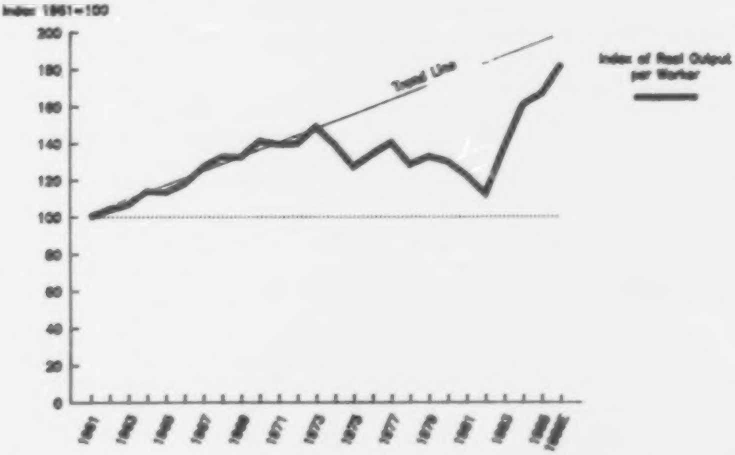

Figure 3. Canadian Primary Mineral Production Productivity 1961-1986

The 1981-86 period is perhaps the most remarkable. In a few short but painful years, the industry essentially regained a decade of lost productivity. Consider the following: in 1981, mining, smelting and refining directly employed about 138,000 people in Canada. The 1987 total is only 105,000, but output, as measured by the gross domestic product series, will actually be higher. If anyone needed an example of the ability of Canadian mining to respond to competitive pressures - there it is. A remarkable, albeit painful, performance.

The lesson I read from this figure is that, regardless of output price trends, the health of Canadian mining rests upon steadily increasing productivity. It is worthy to note that our current position on the chart is just about where we would have been, had the trend of the 1960s persisted through the 1970s.

Continued improvement in the industry's improving economic performance will require further steady increases in productivity. Even though this goal becomes more and more difficult to achieve each year, a developed and sophisticated country like Canada can meet the productivity challenge. There are many resources available in industry, governments and the universities that can be mobilized to help keep industry on the productivity growth path. The hard part is to use these resources to the greatest possible advantage.

Positive steps have been taken recently to help keep the industry competitive. The Mineral Industry Technology Council of Canada (MITEC), for example, is primarily an industry initiative designed to ensure that the scarce resources available for mining research and development are used efficiently - whether the expenditures are made by company, government or university laboratories. Quoting the Council's own literature:

> MITEC will liaise with companies, to identify and priorize the industry's needs. It will work with existing research and development delivery agencies, to implement appropriate programs and projects. Delivery agencies include industry's own facilities, universities, government laboratories and consultants.

This is exactly the approach for which I have been arguing for many years and I am thoroughly delighted industry did pick up the challenge. We now have a structure in place, and so begins the hard part - making it work. I can assure you that the growing integration and rationalization of mining R&D activities is welcomed and encouraged by my department, as indicated by the recent changes at the Canada Centre for Mineral and Energy Technology (CANMET). I refer here to the new minister's National Advisory Council on CANMET, which will act to ensure our activities target more closely the needs of the industry. The role of the advisory council has been strengthened to give it a more direct role in the planning and execution of CANMET's activities.

Again, this is a new structure. The hard work of breathing life into it has just begun. This is one more confirmation that mining is making the changes required to let it thrive in a sophisticated society. These changes include the involvement of other sectors of society in the industry's decisions and working to ensure available resources are used in the most efficient manner.

Mining and the Environment

As mentioned earlier, economic changes are one of the facets of the growing sophistication of our society. Of course, more is changing than just the economy. One of the trends I have followed for years concerns how we regard the environment - an increasingly important area for all those involved in minerals and metals.

It was not too long ago that we considered environmental concerns were pursued only by fringe groups, by certain environmental groups or particular segments of society. This is no longer the case. Polls now suggest that environmental concerns are in the mainstream of individuals' and society's list of priorities - a general change in the way people view their physical environment and a change with growing consequences for mining.

All developed countries seem to be more and more concerned with the environment. After all, what is the point of becoming more prosperous, if we do not have congenial surroundings in which to enjoy our good fortune? The past decades have supplied many awesome demonstrations that, as our technology advances, our power to disrupt nature takes on frightening proportions. We, as a society, can no longer tolerate mistakes or disregard the environment, if only because we cannot afford the cleanup.

This change in attitude could lead to trouble for mining. Rightly or wrongly, industry is perceived to have a poor record in regards to environmental issues. Given the political nature of these concerns, this perception could prove very damaging. Also, we all know there are time bombs ticking away that could have major consequences. It is my impression, however, that there is good will to be earned, depending on how issues are handled.

An adversarial approach is not likely to succeed. It is expensive, time-consuming and only serves to make sensible compromise more difficult. Given the current attitudes, I am afraid mining would lose most acrimonious disputes on environmental issues. On the other hand, if industry takes the initiative in dealing with these issues, all segments of society may consider the industry's position with more sympathy.

For example, the approach on mine tailings taken by the Mining Association of Canada (MAC) at the recent Mines Ministers' Conference is a very good step. Mine tailings are certainly among the environmental time bombs whose ticking has recently become audible.

The MAC took the initiative to bring this issue to the attention of the EMR ministers before others raised it. As a result, existing organizations of cooperation, in this case the inter-governmental working group on the mining industry, will be able to get a head start in finding solutions in a non-confrontational manner.

This kind of approach, which recognizes that mining cannot afford to ignore the concerns of other interests in society, is the only way to move into the future. Furthermore, the ultimate solution will be much cheaper since the involvement of potential adversaries at an early stage allows resources to be used efficiently. This is the mature way to handle such problems, and, I hope, a model for future actions.

Conclusion

In considering the challenges to Canada's mining industry, my approach has been to look at some of the key factors that will shape mining in Canada in the coming years. The industry needs to maintain profitability and to attract investment in competition with the growing manufacturing and service sectors of our economy. This means the need to maintain productivity growth and to deal with environmental concerns. And, due to the industry's diminished political clout in the future, the need of mining to cooperate with other sectors will grow.

The steps mining has taken to date to better integrate itself and to make the best use of the advantages found in a sophisticated society are only the beginning. We must not think of them as temporary steps taken in reaction to the recession, but as a new permanent direction for the sector. The only constant is constant change.

How does government fit into this? The philosophy contained in the new mineral and metal policy of the Government of Canada is well suited for the conditions described above. This policy defines a role for the federal government, one which recognizes the roles and challenges faced by others involved in the sector, including industry and the provincial governments; one which commits the federal government to be flexible and supportive, but recognizes that management, labour and investors are primarily responsible for responding to change. Many of the structures that will ensure mining continues to thrive in Canada are in place. The job now is to supply the energy and the will to succeed - things which have never been in short supply in the mining sector, and for which industry can find support in its many friends in government.

THE CHALLENGE OF NEW MATERIALS

Peter McGeer

Introduction

The Canadian resource industry cannot ignore the changing environment and the emerging competition from new materials. Strategies and policies must be reexamined; very significant changes are necessary in the business plans of Canadian mineral processing corporations. Some companies are fighting back. Unfortunately, most of the industrial and academic world is not reacting quickly enough. A solution for Canada encompasses many issues. Among them are the role of universities, free trade, networking organizations, and the creation of an environment favouring technological innovation.

The Changing World

What changes in our environment must we recognize? Combined with external change, there is a question of substitution - the substitution of one material for another. This is a game as old as history. Metal replaced stone in tools, the rifle replaced the bow and arrow. The new factors are the rapidity with which substitution is occurring and the effects this will have on our commodity minerals and materials industry.

A second change is a new philosophy in design. The designer is searching for materials which will satisfy the functional requirements of the equipment or system being designed. N.P. Suh of the Massachusetts Institute of Technology[1] has proposed two design axioms which must be satisfied: first, the independence of functional requirements must be maintained, and second, the information content must be minimized. This explicit approach to design, combined with the available new design tools, such as computer graphics, and a much greater understanding of how materials behave, is leading to more sophisticated uses of material and more complex combinations of materials to achieve the same function.

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1. Nam P. Suh, "Manufacturing and Productivity", Innovations in Material Processing, Sagamore Army Materials Rec. Conf., vol. 30, 1985, pp. 9-52.

Another pressure we are facing arises from the Global Village in which we live. For many years, Canada was in a very strong position with respect to being the long-term, lowest cost producer of mineral commodities. We had good orebodies, modern equipment, a good work force and very low international barriers for commodity materials. Much has now changed and news comes often of yet another developing country opening a mine or a plant for the production of a material or metal produced in Canada.

Many Third World governments see mineral or metal production as an opportunity to earn foreign exchange and increase employment. Usually, because of rich orebodies, low-cost loan financing, and low labour costs, such enterprises end up being the lowest cost producer. In addition, such government-owned capacity does not follow normal economic rules, and, since the maintenance of employment and foreign exchange earnings are overriding priorities, the minerals and metals produced in the Third World may well be sold at below the cost of production.

The fourth change is market saturation and market diversification in the developed countries. What do consumers in the industrial countries now want to buy?

Materials Consumption

The June 1986 Scientific American published an article entitled "Beyond the Era of Materials". Although I do not agree with the article's conclusion, I think it is useful to look at the data presented. (Incidentally, the November 1986 issue was devoted to the burgeoning use of new materials).

In order to determine the success of a material by measuring its market growth, we can measure its utilization over time against one of two criteria. The first of these would be consumption per capita, while the second would be consumption per unit of gross national product (GNP).

The lower part of figure 1 shows U.S. consumption per capita against time for steel. This is a smoothed curve, and, as is evident in figure 2, the levelling off shown in figure 1 is actually a decline. A real decline in consumption per capita has been occurring for some years. This is the typical "S" curve for the initiation, growth and maturation of consumption of any material or product. At introduction, the consumption of the new material or product is necessarily low, with vast potential markets. As people learn about it, use grows very rapidly and early growth leads to improvements in quality and a reduction in cost. Such changes stimulate the continued growth of demand.

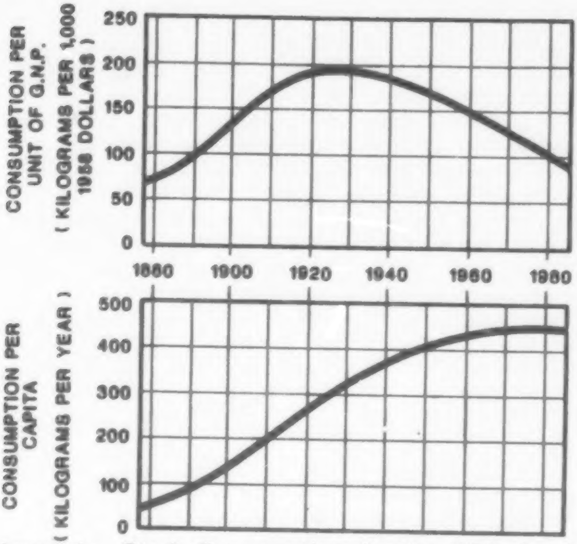

Figure 1. Steel Consumption in the USA As A Function of Time

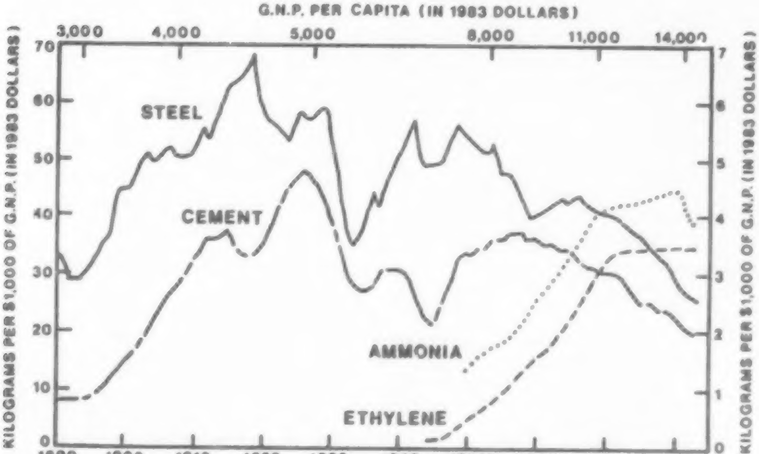

Figure 2. Consumption Per Unit of GNP of Steel, Cement, Ammonia and Ethylene

Eventually, however, the markets for the material mature and become saturated and substitution leads to a decline in per capita consumption.

An alternate way to look at consumption is to measure it against consumption per unit of GNP. Against this measurement, use of a commodity begins to decline at an earlier time than does consumption per capita. This is because, as we move along in the cycle, product sophistication grows and the amount of material needed for a given use decreases. Putting it another way, per kilogram of material, there is an increase in value added in manufacturing.

What we are seeing is a general rule. Figure 2 shows this is a consistent pattern, as exhibited by four well-known commodities. Ethylene, a very new material, is showing this classical pattern. Plastics, and raw materials for plastics, can expect this fate as well, with an even more rapid cycle from introduction to maturity to decline.

Another way to illustrate the metals scenario is shown in figure 3. Steel, nickel, aluminum and copper all are seen to suffer the same fate, with the same 1973 turning point. Although the oil crisis has been blamed for this adjustment, it is possibly more fundamental in nature. The oil shock itself may not have been the result of the formation of OPEC, but rather the effect of this fundamental materials consumption picture.

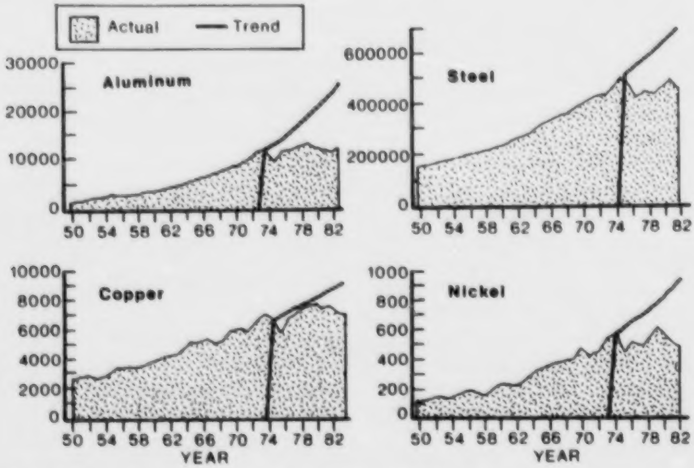

Figure 3. Western World Consumption of Major Metals, Actual and Trends, in Thousands of Tonnes, 1950-81

On the other hand, one could argue that we learned to become a conserver society and that OPEC was a trigger event for a change waiting to happen. Perhaps Silent Spring by Rachel Carson and The Club of Rome publication The Limits of Growth had sensitized western society for the need to move away from conspicuous consumption. In any case, the change clearly happened.

Substitution

In considering substitution, case histories will serve to make the point. Let me quote five examples ranging from our traditional materials to some very new ones, and old materials in new uses.

The first of these examples is the beverage container. In North America the aluminum can has replaced the steel can in all jurisdictions (except one, which has a very strong steel lobby). The aluminum beverage container, in turn, is now being threatened by the plastic can.

An earlier substitution which is also essentially complete is that of aluminum for copper in overhead conductors. Here the conductivity-to-weight ratio for aluminum is so superior that copper was unable to maintain its market. On the other hand, because of its malleability and ductility, copper has maintained almost total market share in house wiring. For signal transmission, however, it appears that the superior performance of fibre optics will allow it to displace copper almost entirely in the not-too-distant future.

To turn to a more advanced industry, consider what is happening in semiconductor chips: not long ago, semiconductors were all silicon, but gallium arsenide is now taking over a substantial part of the market.

A final example is in the area of lead frames and bonding wire for chips. The bonding wire for these chips was almost exclusively gold on aluminum frames. The aluminum industry is attempting to displace gold from this market, but the latest information suggests that copper may be the ultimate winner in this contest.

Product Sophistication

In discussing the decline in use per unit of GNP, we spoke of product sophistication with the concommitant increase in the efficiency of the use of the material. In the beverage container, for example, as illustrated in figure 4, the thickness of the can wall has decreased substantially over time, which of course means a decrease in the amount of aluminum per can. When you consider the USA uses 60 billion beverage containers annually, a few grams per can adds up to an extremely large amount of metal. Recycling of the beverage container, which has reached between 50 and 60 percent of the total produced, has also substantially decreased demand for primary metal. Canning in aluminum for the U.S. market illustrates these points very well. Between 1975 and 1985, the annual U.S. market for beverage containers grew by 96 percent - from 31.5 to 61.5 billion containers - while the tonnage of canning sheet required grew by only 31 percent, due to the decrease in gauge. The consumption of primary metal (i.e. new metal made from alumina) grew by only 2 percent because of the growth in recycling from 25 to 55 percent.

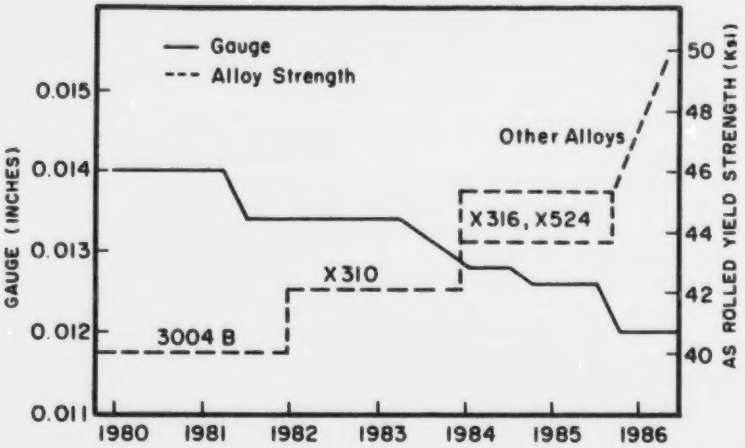

Figure 4. Historical Can Body Stock Showing the Trends In Down-gauging and the Response for Higher Strength Alloys

The weight-to-horsepower ratio in locomotives has changed with the years, as shown in figure 5. Initially, locomotives were built with boilers of riveted cast or sheet iron. As steel making and properties of steel improved, the amount of steel required to make a satisfactory boiler decreased. Finally, an even larger decrease occurred with the arrival of the electric locomotive. And the properties of steel continued to improve. The most recent development - high-strength low-alloy steels (HSLA) - makes one kilogram of HSLA steel as strong as 1.3 kilograms of carbon steel.

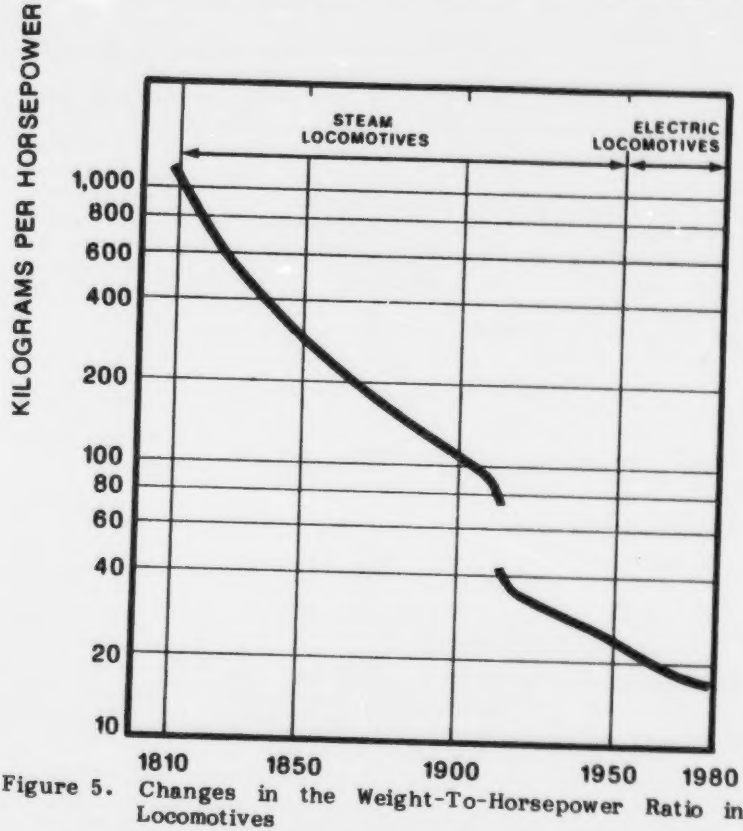

Figure 5. Changes in the Weight-To-Horsepower Ratio in Locomotives

Automobile tires show another facet of product sophistication. The introduction of the more durable radial tire has substantially increased road service life over that provided by the bias belted tire. As a result, the tire replacement market has decreased substantially.

The 24 September 1987 edition of the Toronto Star noted that the Harris Steel Group was shutting down their Frankel structural steel fabricating plant. In explanation, it was noted that the Scotia Plaza Building then being built in

Toronto would use only 4,500 tonnes of steel, whereas 30 years ago a similar building would have required 30,000 tonnes of steel; First Canadian Place used 45,000 tonnes of steel, where as if it were being built today the main material used would be concrete.

In the same article, a steel company executive is quoted as saying: "cars are smaller, that is a fact of life, but the dominant material is steel and all the projections are for the next 10 years that it will continue to be steel". Figure 6 is based on projections made by Jewett[2], but there are other less optimistic scenarios for steel. One possible car of the future already in development sports a body made of aluminum on which one might hang plastic panels to complete the structure. The plastics industry is very active in Detroit and they too have different scenarios. At the March 1987 Metals Congress, Ford was exhibiting major structural body components made of plastics.

Projected Use of Materials (pounds per car)

Material	1980	1985	1990
Steel (low-carbon & HSLA)	1,900	1,600	1,300
Iron	500	300	250
Plastics (nonreinforced, fiber-reinforced & metal laminate)	200	240	300
Aluminum (cast & wrought)	120	150	200
Glass	90	70	50
Other	490	340	150
Total	3,300	2,700	2,250

Figure 6. U.S. Produced Pasenger Cars

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[2] George Jewett, "U.S. Automotive Industry in the Eighties: A Domestic and Worldwide Perspective," Second Delphi Forecast, Arthur Anderson and Co., 1981.

Thus, we all face a similar problem: will our material be displaced, or can we displace another material? The automotive steel manufacturer is in a position similar to that of manufacturers of mechanical cash registers when the electronic cash register first appeared. Mechanical cash registers have gone the way of the dinosaur, together with the corporations that manufactured them - except for one company, NCR. How did it survive? Basically, the CEO fired all managers committed to the mechanical cash register. That may seem a drastic solution, but what is the alternative? If we do not wake up and accept the inevitability of change and move as fast as the change is occurring, we will not survive. Failing such action, we deserve to be fired, or we will effectively be fired because our corporations will disappear.

The New Philosophy in Design

In general terms the new philosophy in design is reflection of the "leaner, meaner" philosophy every corporation is now espousing. We must be leaner and meaner in our organizations and in our materials, and new materials are permitting the designer to follow this philosophy.

Recently, the Science Council of Canada, dealing with advanced industrial materials (AIM), which have been identified as one of the three essential core technologies for Canada's future, stated:

> The basic thrust of technological change in AIM is to substitute lighter, stronger, more corrosion resistant, cheaper, specially tailored materials (ceramics, advanced alloys, composites, and polymers) for the traditional materials on which the Canadian economy is largely based. Canada's resource-based economy faces a serious threat from these developments in AIM, which will make some traditional materials obsolete and reduce the production volumes needed for others.[3]

The spectacular advances in science and technology have given us a whole range of new materials. For those of us who are old enough, it is interesting to remember what the world was like when we were young. In 1935 DuPont marketed the first synthetic rubber, Duprene. I remember that until the late '40s you had to reinflate your tires weekly because the synthetic rubber of the time was slightly permeable. Now we have superior elastomers, dedicated to specific uses such as temperature-and solvent-resistance. The first nylon was spun in 1938, and now synthetic fibres have captured the apparel, home furnishings, and automotive fabric markets to such a degree that there is no further growth for synthetic fibres in these fields. All that in less than 50 years. Some developments, of course, take longer. The age of ceramics was first bruited nearly 35 years ago, and we are now in the third push, in which I think real progress is being made, to make the age of ceramics a reality.

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[3] Science Council of Canada, G. Steed, S. Tiffin, "A National Consultation on Emerging Technology," Discussion Paper, May 1986, p. 45.

These advantages in engineered materials give the product designer an opportunity to select from a number of options to meet design needs. The designer can seek various combinations of weight, ductility, fracture toughness, tensile strength, etc., to satisfy the end product design requirements. Focus will be on product utility and product cost, and the designer can and will set material performance requirements which actually dictate the manufacturing process specifications. As a consumer, the designer will be selecting from an ever-increasing range of available materials to meet his or her needs. These needs are as follows:

- improved performance;
- less energy for manufacture;
- extended properties;
- simplicity in manufacture;
- more transportable energy;
- longer service life;
- more efficient energy use;
- unique properties.

Figure 7 provides a "quasi" phase diagram of the current materials world. The more conventional materials appear at the apices of the tetrahedron. The coming world, however, lies either along the edges or within the tetrahedron in the combinations of these basic materials.

Materials Combinations

The designer can also use combinations of materials, and one way to satisfy Suh's first axiom - that the independence of functional requirements must be maintained - is surface

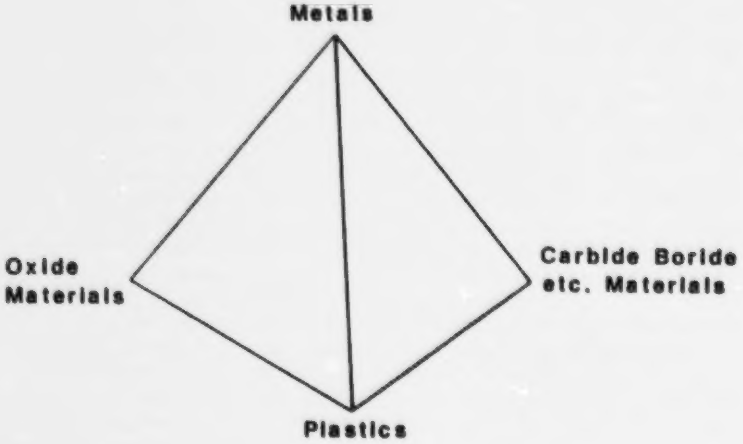

Figure 7. The World of Engineered Materials

modification. For example, this gives the option of using a relatively inexpensive material as a base, with a coated surface to carry out some specific function. There are a variety of ways to modify surfaces: magnetron sputtering, ion implantation, plasma or laser spraying, coating, glazing and electro-coating. Laser and electron beam surface melting can produce rapidly solidified layers with excellent anti corrosion properties. Plasma-sprayed coatings of titanium diboride on, for example, steel or aluminum can significantly increase abrasion resistance. Those who have used an aluminum snow shovel on a cement walk know how rapidly the metal abrades: if only some manufacturer would come out with an abrasion-resistant coating on the working surface of an aluminum snow shovel, and thus provide a combination of light weight and abrasion resistance.

Combinations of materials to achieve functional independence can be achieved in the internal combustion engine. An aluminum piston provides lighter weight and lower inertia. A potential problem arises, however, with temperature resistance in the crown head. A way of overcoming this is to use a metal-matrix composite - aluminum/silicon carbide, or aluminum/alumina fibre - in the crown. Another problem with aluminum cylinders can be wear, particularly in the ring holder area. Once again we can use a metal-matrix composite reinforcement in this area for substantial wear advantages.

One material competing for these applications is ceramics, as epitomized by the proposed ceramic engine. This use of ceramics, however, can violate Suh's second axiom, which is to minimize the information (for "information" read "technology") in the manufactured part. The development of ceramics for such applications as the cylinder, cylinder crown head and piston ring holder requires a substantially high degree of information. Thus, on a cost-benefit basis, metal-matrix composites in internal combustion engines are greatly superior to ceramics. There will, however, be areas where ceramic components can satisfy some very specific needs in internal combustion engines: for example, for valve seats and exhaust port liners.

Laminates provide yet another way to exploit combinations of properties. Wave guides and aerials on orbiting satellites, for example, must satisfy a rigorous set of demands: stability in a vacuum, resistance to intense radiation and a zero coefficient of thermal expansion, since one side will be exposed to sunlight and the other to 0 K. An aluminum/carbon fibre laminate meets this very demanding set of properties. The aluminum exterior provides integrity with exposure to radiation, while the carbon fibre in the laminate gives the end product a zero coefficient of thermal expansion.

The new technology for creating very light-weight pressure vessels being developed by Baycomp, provides another example of ways to exploit combinations of properties. Baycomp's pressure vessel is created by winding thermo-plastic fibre materials around a thin metal cylinder, so that the metal is in compression while the fibres in the coating are in tension. The end result is an extremely light-weight vessel capable of handling very high pressures. The independent functions of nonpermeability to gas and resistance to pressure are thus met by combining the two different materials.

Saturation

North American homes are essentially completely equipped with refrigerators, stoves, washers, dryers, automobiles, etc., which means slower demand growth and even decline for steel. Steel is also going to suffer due to a shrinking railroad network, and to the likely change to aluminum rail cars in unit trains for moving commodities. As for automobiles, the average life is now 7.4 years compared to 5.5 of a few years ago. Disposable income, which in the first decades went largely to the acquisition of the consumer goods noted above, is now being spent on very different items - home computers, and health clubs, and other items with lower metals content.

Unfortunately, for reasons of cost of shipment, lack of income, and/or tariff barriers, we cannot expect these metals-intensive markets to be replaced by markets in the Third World - one more nail in the coffin.

Fighting Back

To find success in today's world, a corporation must either be a low-cost producer of a commodity product or it must corner a market niche with a successful dominant product achieving an above-average profit market. Two reasons, however, make it difficult to maintain a position as a low-cost producer of a relatively indifferentiated product such as ores or primary metals. First, there are often only very small differences in production costs. Second, as pointed out earlier, many materials and metals produced by Canada face a major threat in the form of growing production in developing countries.

Although some companies may be in a position to be the low-cost commodity producer, for many the challenge is to achieve the other kind of profitability: the development of sophisticated products which give a market niche. Last year the Globe and Mail reported on a study carried out in Germany on a cross-section of companies, running the gamut from chemical engineering and plastics through wood processing and foundry manufacturing. The study showed that a proportion of the companies could be classed as successful in that, against the recessionary trend, they maintained at least their level of output while achieving above-average profit performances in their field. More than 80 percent of the companies extended their product range and attributed their success to innovation. Thanks to new products, companies could market at prices that allowed higher profits. The study clearly showed that the key to success is product innovation, primarily in the area of goods new to the market.

The task force on Federal Policies and Programs for Technology Development stated:

> While developments in the more glamorous, strikingly original fields such as bioengineering

> or fifth generation microtechnology will be important to the country's future, we suspect that most of tomorrow's technological success stories will involve the use of Canadian skills to develop creative new adaptions and extensions of existing and imported technologies. If we are lucky, most of our triumphs will consist of brilliant adaptations using new technologies to revitalize old industries such as forestry, metals, mining, fishing, manufacturing or even textiles. New industries will be created through the application of high technology, but the biggest impact of technology in Canada will be from the redemption of existing industries.[4]

Examples of Fighting Back

Several examples of fighting back may be useful in stimulating thoughts. Some of these examples are aimed at niche markets, some are broader.

In the report for the Office of Technology Assessment in the United States on new structural materials technology,[5] it was stated that the composites introduced into the horizontal stabilizer of the F14 fighter in 1970 have now become the base-line materials in high performance fighter and attack aircraft. As for civilian aircraft, one scenario predicts that the major component in the next generation of commercial aircraft is likely to be composites.

The aluminum industry responded to this major threat to one of its more significant markets by reviving a family of alloys first described about 35 years ago, the aluminum/lithium family. Initially the alloy's outstanding property - a significantly lower density, much lower in fact than the proportion and density of lithium would suggest - was regarded as a curiosity. But, faced with the threat from plastic composites, the aluminum companies developed the alloy and overcame problems which the earlier, simpler alloys had presented.

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[4] Ministry of State, Science and Technology Canada, Report on the Task Force on Federal Policies and Programs for Technology Development, Chairman Douglas Wright, Ministry of Supply and Services Canada, July 1984, p. 4.

[5] U.S. Office of Technology Assessment, A Technical Memorandum, "New Structural Materials Technologies: Opportunities for the Use of Advanced Ceramics and Composites", September 1986.

One family of these alloys was developed by the Royal Aircraft Establishment of Great Britain in combination with Alcan. These alloys offer a potential for weight savings of around 10 percent by direct substitution for conventional alloys, and up to 15 percent or even more if designs take into account the cumulative effects of weight saving and the improved stiffness of these new alloys. The alloys have better fatigue behaviour, behave very well in fabrication, have excellent extrudability and machinability, and demonstrate super plasticity. The overall result is a scenario in which aluminum is expected to maintain a significant share in the next generation of aircraft; instead of dropping to as low as 11 percent of the total weight, alumimum will probably maintain a share greater than 50 percent.

In the zinc industry, substitution has been fought off by Noranda by the development of a new family of alloys. This Canadian effort has developed a family of zinc/aluminum alloys for gravity, sand, and pressure diecasting. These new alloys, which are lighter than conventional zinc casting alloys, extend tensile strength performance at high temperatures for continually stressed applications. Zinc/aluminum alloy motor mounts produced by British Leyland, for example, fulfill requirements for strength and impact capability at high temperatures. A diecast front axle tube for a light truck replacing a four-piece steel/plastic assembly, to give another example, demonstrates a revolutionary application which takes advantage of the ability for near-net-shape casting as well as the alloy's high shear strength, light weight and good machinability.

Sherritt Gordon has developed new markets for cobalt. The company, which was seeking high value-added markets for their cobalt powder, developed a commercial production process for high energy magnets by combining the powder with samarium oxide. The excellent energy properties of these permanent magnets are developed through special heat treatment. Although neodymium-iron-boron magnets have slightly higher maximum energy, they do not have nearly as good a corrosion resistance as the samarium-cobalt magnets, nor will they stand as high a temperature of operation.

Other examples can certainly be cited. Dofasco and Stelco are planning to produce interstitial-free steels which will greatly improve the formability of steel sheet. Cominco has elected to produce gallium arsenide materials using a byproduct from their smelter operation in British Columbia. As a yttrium producer, Denison Mines holds a potential opportunity since one of today's major excitements is the use of the material as a component for the high critical temperature, super-conducting ceramic materials.

Actions the Industry Must Take

To recapitulate the challenges:

- substitution is occurring at a rapidly growing rate;
- a host of new materials such as plastics and ceramics are appearing in the structural and functional materials world;
- the designer is seeking to use less material for better performance, and many of the new engineered materials permit this;
- the Third World is going to be the major low-cost producer of minerals and most metals;
- the market for commodity products is essentially saturated;
- some companies are beginning to fight the loss of their major commodity markets by developing niche markets.

Unfortunately, the response so far has been minimal and fragmentary. Our governments appear to be leading the activity while corporations are lagging. The Government of Ontario, with its initiatives for Centres of Excellence, particularly the one in the area of materials, appears to have recognized the need for better knowledge in the area of advanced industrial materials. The federal government has reorganized, merging its policy arm, the Ministry of State for Science and Technology, with its action arm, the Department of Regional Industrial Expansion, into a new ministry including a Directorate of Advanced Industrial Materials.

The industrial and academic worlds, however, seem to be reluctant to change the old way of doing things. We need to activate ourselves in new ways. To quote the comment made famous by Dorothy Parker during second world war: "If the ship has been torpedoed and you can't make up your mind whether or not to get in the life boats, your mind will be made up for you."

The knowledge holders (and here the universities must play a prime role) must learn to look at materials as an engineering opportunity. Universities can no longer separate academic teaching into the conventional disciplines, each living in its own separate world. Materials engineering requires the discipline of the component designer: knowledge of the relative strengths and weaknesses of materials. The material engineer must learn to work with the component designer to compare and contrast materials falling within the tetrahedron. The materials engineer who does not have a broad grasp of the options and knowledge of relative properties and how different kinds of materials can be combined will not serve our future and will not serve a materials industry.

Corporations must develop policies which look to technology as a source of industrial strength - a particularly difficult task in today's world. Unfortunately, the directions taught by business schools frequently lag significantly. The disciplines of financial manipulation still taught by business schools may make some individuals rich, but will not ensure the country's survival. We need a corps of enlightened chief executive officers in Canada who will lead their corporations towards new products, who will adopt this aim as a corporate strategy, and who will develop technology plans to ensure the survival of their corporations in the longer term.

We should accept free trade that with open arms. Free trade is the only way we can ensure our industries are competitive on a world basis. Why are we as Canadians afraid to compete? Why is it that when we discuss free trade, some sectors howl in protest? Even through free trade will mean some job losses in areas where we are inefficient, the opportunities to gain jobs, and to gain in our balance of trade is so much greater that we cannot afford to let special pleading ruin this initiative.

We should also, where appropriate, support and participate in networking organizations such as the Canadian University Industry Council on Advanced Ceramics (CUICAC) and the Canadian Advanced Industrial Materials Forum (CAIMAF).

Finally, Canada must reward applications of technology to our resources that create competitive advantage in products for tomorrow's world. That reward may come through the tax system or by arranging for such initiatives to lead to wealth. Certainly we will be doing far more for Canada if we ensure that the way to become wealthy is through generation of new wealth, rather than through financial manipulation, green mail or leveraged buy outs. Our legislators could create laws to assure that technology is rewarded to a much greater degree than it is now. We could develop a system that rewards technological innovators and penalizes financial manipulators, if that is what we in Canada really want.

Canada has an adequate base of knowledge and manufacturing resources. Provided we harness all of those resources effectively, we can succeed. We must overcome our provincialism, our parochialism, and our resistance to change. It is only through generating change in our mineral industries that we will ensure their survival in the 21st century.

QUALITY OF WORKING LIFE: THE CHALLENGE OF OCCUPATIONAL HEALTH AND SAFETY

Beverly Harris and
Albert Cecutti

The Key Issues

The mining industry in Canada should be aware of eight key occupational health and safety issues demanding action:

- advancing technology in metal toxicology;
- labour involvement;
- compensation for loss versus welfare;
- regulatory activity;
- real commitment from management;
- the regulators' role;
- the role of preventive medicine in the workplace;
- the role of professionals.

Metal Toxicology

Knowledge in metal toxicology is increasing but there are still many unknowns. Much of the current information is based on in vitro and in vivo studies. We do know, for example, that lead and mercury cause both acute and chronic health problems; nickel, chrome, and other metals cause dermatitis; and many minerals and metals, for example asbestos, silica, coal and nickel, have been implicated in chronic obstructive lung disease and lung cancer. Some diseases are specific to the metallic form and also its compounds, others to specific compounds of the metal, and there is increasing evidence that some problems are related to specific metallurgical intermediates in the process. Also, during the processing of minerals, numerous chemicals are used (for example cyanide) that have real health hazards.

The role of industry is to deal properly with known hazards and to research, and/or support research on unknown hazards. This is the challenge - not to be afraid to face the problem and discover the truth.

Unions

In the past, the focus of unions has been primarily on improving benefits. With little more to be expected in benefits and with decreasing membership, unions are now emphasizing health and safety issues as a rallying point to maintain their position and support. To this end they are pressuring regulators in an organized fashion and becoming more knowledgeable themselves in occupational health and safety. Management and supervisors must become more aware of the issues and facts relating to occupational health, and the challenge of the 1990s is and will be directly related to the balancing of these pressures with science.

Traditionally, the industry's response to known problems has not been very good, and it has done little to uncover other occupational health problems. In order to do this, it must perform more risk/benefit analysis by getting the technical people to provide the data to make these scientific decisions. Furthermore, the CEOs must use their influence in the political arena to promote health and safety concerns.

Compensation vs Welfare

Compensation was first introduced to provide for the loss of wages resulting from work-related injury or illness. However, the principle has changed, and we now pay the employee for pain and suffering, regardless of whether the cause is totally attributable to the workplace. Two common examples are cancer caused by smoking, and back pain from degenerative disc disease. Traditionally, there had to be a definite link between an event and an accident or disease. Now if even the suggestion of such a link is there, the compensation, and therefore the industry, pays.

Let us consider the Meuller Report on gold miners and cancer[1] which reported a standard mortality ratio (SMR) of 145 for the whole group. A closer look at this figure, however, shows that the SMR was less than 100 after 1945, whereas before 1945 it was approximately 200. The problem, therefore, was pre-1945. The position taken by the Workers' Compensation Board (WCB) is that any gold worker with lung cancer will be compensated. It is estimated that there will be 100-140 such cases, with an average cost of more than $100,000 or even $200,000 per case, for a total cost of

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[1] G. Mueller, "Study of the Mortality Rate of Ontario Goldminers," Ontario Ministry of Labour, July 1986.

$10-20 million. From a scientific point of view, however, cases of lung cancer arising before 1945 should be compensated, while those arising after 1945 should not.

The challenge is to apply scientific data for appropriate compensations, taking into consideration such lifestyle factors as smoking. The mining industry should be responsible for that which it causes, but not for problems related to lifestyle or natural aging, at least not without some sort of tax benefit or cost recovery.

Lifestyle

Should the mining industry interfere in an employee's lifestyle? We must look at the impact of lifestyle on the worker, its affect on productivity and the costs.

Most, if not all, mining companies provide benefit packages covering sickness, accident and death benefits. From that perspective alone, companies should be interested. We know lifestyle habits can directly influence occupational accidents and diseases. Alcohol and drug abuse contribute to accidents and disease, smoking contributes to cancer. We know that in the aging workforce, heart disease is the leading cause of disease, disability, and death. We also know that with the exception of heredity, factors contributing to heart disease are related to lifestyle.

Is the community at large really concerned about these costs? Since consumers pay the cost of the product, they should be concerned, but in actual fact they are not. And does industry have a role? The answer is yes, it should play a role. The challenge will be to determine how it plays that role. We should look at a number of areas: the introduction of employee assistance programs, smoking cessation, general fitness and cancer awareness programs, blood-pressure screening, and stress management. The costs associated with these programs are more in human resources than in capital. And these must be ongoing programs, not simply the occasional blood-pressure reading or a brochure on how to quit smoking.

Regulators' Role

Governments have tried to solve occupational health and safety problems by establishing regulations, thereby leaving little opportunity for employers and workers to resolve their own problems. This process forces industry to focus on regulatory issues rather than the real issues.

The role of regulators, therefore, should be threefold:

- to set guideline-type regulations based on scientific criteria. These should be general rather than too specific, allowing flexibility in the application specific to the needs of the individual company or industry;
- to audit industry's compliance to these guidelines. If compliance is met, people should be told so; if not, advice should be given regarding problems or possible improvements. Some form of enforcement (financial?) should be available if corrections are not initiated;
- to encourage and support accessibility for smaller industries to the professional resources needed to assist them in meeting these guidelines. This could take the form of support to educational institutes to facilitate the increasing need for knowledgeable occupational health and safety professionals.

The mining industry should be aware of and look at alternatives to legislative occupational health and safety regulations. It must also, however, be aware of the fact that, in the face of deregulation, the industry, and individual companies, must consider needs, concerns, and issues, and set a plan of action to investigate and resolve them.

Commitment

Every corporation's policy statement should include consideration of occupational health and safety. Each company has its own specific objectives for safety, for example a 10-percent decrease in medical aids. The policy statement, however, should include plans for a program that will help to realize its objectives. The statement and program should be well publicized and acted on, and there must be funds directed to facilitating the accomplishment of these objectives.

The challenge of the 1990s? Put the issue of occupational health and safety in the forefront of corporate planning.

The Role of Professionals

The major role of health professionals utilized by industry in the past has been a policing role, to weed out any unfit people at the time of pre-employment or during employment. Today, with more protective human rights and labour legislation, this unappropriate role is diminishing. Industry must nonetheless ensure that employees are not placed in a job where they are a possible hazard to themselves or others, and that the workplace or job is not a hazard to the worker.

Who is assessing this risk in the mining industry today? Who should be? Historically, issues in health and safety have centred on safety, probably for two reasons. First is "out of sight, out of mind." A fractured arm from a piece of loose rock is much more tangible than the sensations of numbness and cold felt in the hands of a veteran driller. The response may therefore be to modify the mining methods to decrease the risk of injury by installing remote control equipment with pre-set drilling patterns. But the workers with vibration-induced white finger can probably still drill, albeit with some discomfort. Second, the visible injuries are easily related to today's compensation costs. Not so with cancer, a disease with a long latency period.

Physicians thus played policemen, while experienced operations people dealt with safety concerns. Occupational disease in its broadest sense has be become more widely recognized, however, with government, labour, and professionals becoming more aware of the issues and concerns. Who in the organization should deal with this concern? When the Ontario Occupational Health and Safety Act was introduced safety apparently took precedence, and that is where its application was delegated.

The challenge of the 1990s is to use the right person for occupation health activities - someone with a professional background in occupational health, a specialist. Do not hire physicians because they happen to play golf at the same club, or nurses because their spouses happen to work for you. Do not require ventilation personnel to start monitoring for mercury.

Educational resources and specialty certification programs exist for occupational health physicians and nurses, hygienists, and safety professionals. They are the people governments and labour will be demanding, and they are the experts the industry should be hiring to design occupational health and safety programs.

PROSPECTS FOR MINERALS IN THE '90s

Digest of Discussions

Renka Gesing and
Margot Wojciechowski

Introduction

The Canadian mineral industry has spent a great deal of time in the past decade reacting after the fact to changes in the economic, political, and social environment that have seriously affected its profitability and even its viability. The CRS policy discussion seminar, "Prospects for Minerals in the 90s", centred on the theme of looking ahead to the next decade.

Participants at the seminar identified a wide range of upcoming issues in need of further study, close watching, and even immediate response. One strong recommendation called for the mineral industry to take on a more active leadership role in dealing with its own problems. Areas of concern, all interrelated, can be broadly grouped in the following categories: supply and demand, profitability, trade, health and safety, and the environment. It became apparent in the course of discussions that, even among a group of industry experts, there is still considerable uncertainty about the nature and severity of the likely effects of these issues.

Supply and Demand Issues

Overcapacity and Oversupply

On the supply side, participants warned of continuing overcapacity and oversupply for most minerals in the foreseeable future, on a worldwide basis. The problem was blamed alternately on geologists excited to see their finds developed, on bankers eager to finance new projects which end up rendering old ones uneconomical, and on a relatively new development in mining - the introduction of easy debt financing - which, it has been suggested, is not an appropriate vehicle for development or operation of a depleting asset.

The overcapacity problem was also blamed on an industry philosophy that pushes each company to hang onto its share of the market regardless of worldwide capacity, and to try to bring new mines on stream before the competition. This attitude was compared to the "tragedy of the commons", where it is in the interest of each farmer to add another cow or two to the shared pasture land, or "commons", in spite of the fact that in the end, all the cows go hungry.

Exploration Needed to Counteract Depleting Reserve Base

Overcapacity and poor profitability have led to an overreaction in the form of too little exploration, particularly for base metals. Declining reserves in Canada are raising questions about the country's future role as one of the world's leading suppliers of base metals. Industry, it was stated, cannot afford to ignore its reserve base. Management must show continual commitment to exploration, and not cut exploration activities at every downturn.

Cominco's move to establish Cominco Resources was cited as a good example for the industry. Faced with falling earnings, Cominco had to cut its internal exploration budget from $21 million to $12 million over a couple of years. Rather than cutting its exploration activities, however, it formed a new company, Cominco Resources, to attract outside investment for exploration. Thus, by assigning responsibility for exploration to a junior company, Cominco found new ways to finance its exploration.

The need to improve methods of exploration was also highlighted, with some participants stressing that the industry needs to encourage more innovative thinking. Since all the easy mineral outcrops seem to have been found, not only more exploration, but more productive exploration is necessary. The best way to improve the industry's competitive position, stated one participant, is by finding higher quality reserves.

Canada's south was presented as an area of potential, with new deposits waiting to be discovered in more accessible areas, and even in previous explored areas, as was the case with the Hemlo deposits found along the Grans Canada highway. It was pointed out that since we know very little past a few hundred metres below the surface, new geological techniques could result in another surge of discoveries in already well explored areas. Another area of great potential is Canada's north. Unfortunately, according to one participant, perceptions of economic burdens, expecially the lack of infrastructure, inhibit major exploration in the north. Once the region is seen to be economic, however, its tremendous mineral endowment can be exploited.[1]

Another reason given for the current low level of base metal exploration, is investor interest in gold exploration - thanks to strong gold prices and the tax breaks offered by flow-through shares that appeal to small investors and junior companies. With this favourable environment for the financing of gold exploration, it is difficult to encourage investors to put their money into base metals.

Still on the subject of exploration, one participant wondered if deposits could not be developed in Canada enabling the country to become a supplier of strategic materials such as chrome, manganese, cobalt (70 per cent of which is mined in Zambia and Zaire), or platinum (70 per cent from South Africa).

Another question raised was whether Canadians should try exploring outside their country. Canada's need for economic activity and employment were reasons given for keeping exploration within our borders. On the other hand, it was agreed that Canadians should explore in developing countries, since these countries may in the future make our mines non-competitive. A Canadian presence, it was suggested, could help control the effects of third-world development on Canada's industry.

Volatility in Supply and Demand from Other Countries

Increased volatility of both world supply and demand was predicted, a situation that will be worsened by uncertainties over the supply and demand potential of newly developing countries, of China, of the USSR, and of other regions and countries. Participants expressed the desire to know more about market and mining developments in other countries. Questions asked included:

- how will China, the Soviet Union, or India look in 15 years, both as suppliers and as consumers of minerals?

- how can Canadian industry cope with increasing volatility of supply and of demand from the East?

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1. For another view on exploration and development costs in the north, see: Leo J. Verleun, Brian W. Mackenzie, Mining Potential in Northern and Southern Canada: Guidelines for Regional Development Policy, Centre for Resource Studies, Queen's University, May 1988.

- is there a trend to privatization in the Third World, and if so, what are the implications for Canada?

Participants were able to offer some observations and answers. A surprising fact noted about China is its negligible exploration effort and relative lack of knowledge of its mineral resources. Another problem that country faces is inadequate transportation facilities. As a result, one participant concluded, the Chinese will be significant buyers of consumer goods such as washing machines, televisions and lead/zinc batteries, and significant sellers of some minerals, such as coal from their well-run coal mines. Along the same lines, India was also predicted to become a major goods buyer in the future.

The Soviet Union, although largely unexplored, and a relatively inefficient mineral producer, was also said to offer some surprises. Soviet technology, for example, is generally underrated. Few realize that the USSR has the most modern lead smelting technology, and has developed the best zinc reduction technology, although, to date, only to the laboratory stage. In spite of having good science, the USSR has a problem of translating R&D results into industrial reality, according to one participant. Despite its great natural resources, however, the USSR will continue to be a goods importing country, since it is plagued by low production skills. As a result, it was suggested, the Soviet Union is more likely to be a market than a competitor for most minerals.

This view was disputed, however, by a participant who warned that the danger of competition from USSR mineral producers is very real. The USSR needs hard currency to buy from abroad. If the oil price drops, they may turn to their nickel resources, for example, and become a major seller in the West to generate foreign currency. In this case, any western world reaction such as anti-dumping legislation would be too late to offset price damage. The USSR thus has the potential to interfere dramatically in western mineral markets and to affect mineral prices.

As for the Third World, the situation presented was one of 30 years of poor management. Governments involved, especially in southern Africa, are starting to realize that changes are needed. A trend towards increasing privatization of industry in the Third World may lead to more efficient management. The main third-world countries to watch in the very near future are, according to John MacLeod, the Little Dragons - Taiwan and Korea. In his paper, MacLeod warns of the impact these countries may have on mineral markets and the industry.

Profitability

Participants strongly emphasized that to remain profitable, existing markets must be defended against the encroachments of new producers and new materials, and new markets created. At the same time, in order to stay competitive, Canadian mineral producers will have to fight to maintain their place (along with, it was suggested, 75 percent of the world's mineral producers) on the lower half of the cost curve. This will require continued, novel efforts at cost cutting and closer attention to product quality. Tax reform and capital markets also present areas of uncertainty and potential problems for profitability in the industry.

Decreasing Demand, New Materials

Recent decreases in the demand for metals was attributed to many interrelated factors. One is today's more efficient use of materials, along with the efforts in the manufacturing industry to save costs by using less metal per product: a phenomenon known as downsizing, or the "thinner, lighter, stronger" syndrome. Another factor is the substitution of materials such as plastics or ceramics for use in products that were traditional users of metal. Some participants were convinced that an accelerated pace of substitution will aggravate oversupply problems.

A recurring theme throughout the discussions, as well as in the papers presented, was the arrival of the new advanced or engineered materials on the market, and the fact that the days when the minerals industry could "play the tonnage game" as mere producers of commodities are over. The largest threat from advanced materials to the minerals industry is a significant change in perspective. Up to now, stated an economist, the industry has concentrated on reducing production costs of basic commodities. With advanced materials, however, it was recognized that the added value of processing far outweighs the value of the material itself. The price of the material itself is thus playing a smaller and smaller role. A more important consideration is material properties: what the material can do (as evidenced for example by the current interest in superconductivity); or how easily the material can be worked. Another change in perspective is the development process, or the source of impetus for innovation. With new materials, you can start with a need and then create the material, rather than, as has been the case in the past, starting with the material and designing products around its qualities.

The potential impact of advanced materials on the mineral industry is still unknown. Economists have difficulty projecting the effects of advanced materials, a problem confirmed by the evidence that past forecasts are proving inaccurate. The all-ceramic car engine, for example, is an unlikely development in the near future. The car industry is ready to use only small parts such as turbo compressors to test new materials, according to some participants. Early developments for the use of ceramics in engines have stemmed mainly from the U.S. military effort, but industry has not yet solved the problem of ceramic brittleness. Government money is flowing in, but the technological problems are still enormous.

Plastics are also facing problems, a principal one being the fact that they are not, for now, recyclable. Nonetheless, said a participant, many manufacturers are convinced plastics are the material of the future, because of their attractive and versatile properties.

One participant suggested there is a tendency to overdramatize the potential of new materials dreamed up by scientists, and argued that the future of the automobile is not in plastics but in high strength steel, heavily protected from corrosion by zinc alloys. Other great future possibilities for minerals were also suggested. In the case of stainless steel, for example, there are three major areas of opportunity: corrosion resistance, heat resistance, and hygiene. Hygiene was identified as an area of great potential in the Third World. Substitute materials will not make major inroads in these three areas, it was agreed. There is also a fourth area, transportation, for products such as railway cars, to which both aluminum and stainless steel producers are laying claim as an area of great potential.

Increasing Demand: Innovation, Marketing, Research

Whether or not projections of greatly increased use of ceramics or plastics are realized, seminar participants strongly agreed that the minerals industry must protect and expand its markets. The mineral industry must, it was suggested, focus on product engineering, ensure the availability of qualified experts, and be able to influence fabricating and manufacturing organizations at the level where materials decisions are being made.

Another consideration presented was that, since the industry can no longer rely on the large-tonnage commodity business, it should actively consider niche markets for value-added materials and new uses for its materials. The industry, decided some participants, must be more innovative and look at upstream products; one company, for example, has added a medical researcher to its board of directors. Alcan was cited as an example of a company searching for niche markets; the company studied its strengths to decide which niches to move into, and decided, for example, on ceramics and on gallium, both of which are natural extensions of its own expertise. Alcan is thus turning to new value-added niches as areas of growth, not to primary commodities. At the same time, one participant warned that the industry must be careful not to get into competition with its own customers. This would be the case, for example, if a nickel company decided to produce jet engine material.

One of the largest obstacles to increasing demand was seen by participants to be a lack of marketing skills on the part of the industry. A commitment to improvement of marketing strategies must start with a change in outlook. As stated by a company CEO: "We should stop being diggers, and become materials marketers." The wool industry was pointed out as an example of a resource industry which spends large amounts on generic promotion of its product.

Marketing in the minerals industry should come, it was felt, not only through the promotion of new materials, but also through the promotion of standard applications. One comment was that, in the rush to new materials, the marketing of standard applications has been abandoned over the past 20 years. For example, designers and engineers are unaware of advances in the physical properties of metals and alloys, and some 25-year-old U.S. design codes desperately needed to be upgraded. The industry should be promoting quality, longer life, less maintenance, better style, etc. Companies, felt a participant, are too passive and have given up promoting their own markets. Steel, for example, has lost markets for 500,000 tonnes to plastics in recent years, although it is now working to reverse the trend.

R&D Needs

More research and development was seen as another aspect of the battle to increase demand. It was generally agreed that the industry is devoting too little of its resources to product R&D particularly, and needs to improve links between R&D and innovation. The industry must learn, stated a participant, how to build a bridge between the theoretical and the practical scientific communities. He expressed concern that there is separation of R&D, with basic research considered the exclusive domain of universities, not industry. And there is still much basic research to be done, it was argued; for example we still don't know everything about the properties and potential of copper.

Market development performed in the mineral industry also came under scrutiny. Industry needs a greater emphasis on innovation, it was pointed out. It needs more activities, separate from research, for developing new applications, and the defence of existing markets. The Nickel Industry Development Institute was cited as an example of this type of initiative.

Canadian industry as a whole, suggested a participant, supports the concept of advanced technology, but this support is not evident in the country's manufacturing sector, especially in the area of high technology products. Northern Telecom, an example of the successful development of Canadian advanced technology, was given as one exception to the rule. If this company can realize success in advanced technology, wondered a participant, perhaps others will be able to as well. One theory presented was that the reticence of Canadian companies to pursue high technology ventures is perhaps a question of the high risk that comes with investing in these value-added products. It is difficult, expressed a CEO, to get mining company executives to transfer risk-taking activities beyond the exploration phase.

Another consideration is the high cost of research. Although it was recognized that all companies should be involved in innovation, the promotion of engineered materials, etc., the question remains: Can individual companies afford it? One possible solution offered was the sharing of costs by smaller companies through, for example, networking and joint ventures. The Quebec government tried to encourage this approach by offering incentives to the iron ore industry for this type of cooperation; unfortunately, confidentiality problems interfered with the initiative. Although the difficulty of pulling competing companies together was recognized by participants, there is a growing recognition that companies can profit from cooperation. Alcan and Alcoa are realizing they are not only competing with each other as aluminum producers, but with companies like DuPont and Falconbridge that produce substitute materials such as plastics, copper and zinc.

Cost Cutting, Subsidies and Closing Down Losers

On the one hand, the necessity for increased R&D spending was recognized, while on the other, industry needs to cut costs to stay profitable. The comment was made that Canada, like Australia, has survived in spite of failure to keep extraction costs down, thanks only to the quality of its natural resource base. However, current conditions are reducing the natural-resource advantages in both countries.

One question raised in this regard was: Should depleting assets or mines with high production costs and low yields be closed, especially in times of overcapacity? Although this makes economic sense, and governments accept the principle that they should not prop up losers, in some cases there seems to be no alternative but to keep high-cost operations going. It can often be difficult to justify closure, stressed a government representative. For one thing, competitive positions change quickly, due in many cases to external factors such as quickly-changing exchange rates; for another, citizens' economic and political expectations must be met, at times in conflict with what makes overall economic sense for the industry.

If, for example, a remote mine in Newfoundland is forced to close, there may be no other industry in the region to provide alternative employment. Another participant pointed out that even though you can dwell on the predicted dire effects of reactivating Cyprus Anvil on the price of zinc, the question remains, should Faro, which at one time had one quarter of the population of the Yukon, have stayed closed? In this case, almost the entire population left during the period of closure. And after reopening, the predictions turned out to be unduly pessimistic.

The conclusion that you can not always justify closure in spite of economic realities raised another question, that of subsidies to industries losing money. These were seen to have two areas of impact: one in the case of a local subsidy for an industry supplying a domestic market; the other, a subsidy for the production of commodities and goods for export. In the latter case, a subsidy was seen to benefit not Canadian industry, but the foreign purchaser, as for example in the case of subsidies for the northeast coal development in British Columbia. In addition, this development has hurt many existing coal producers in southern B.C. and Alberta. Even though governments claim they do not subsidize overseas consumers, stated a participant, they do so each time subsidized goods are exported.

Another example of subsidy is the provision of a dedicated infrastructure for the Red Dog mine in Alaska, which will, it was stated, affect zinc prices for years. There was considerable support for the view that a developer should cover ALL costs related to a new project, even for infrastructure in remote regions.

Management, Leadership and Communication

A major restructuring of the mining industry was seen as the price to pay for some assurance of profitability and of a more positive image. So far, however, the industry is seen to be reactive, ad hoc, and fragmented, represented by a variety of mining associations, chambers of mines, prospectors groups, commodity associations, and professional associations. But, complained a participant, the industry does not have the will, the leadership, or the management skills to reorganize rapidly in a world of rapid obsolescence.

Strong leadership could have solved the industry problem of excess zinc capacity years ago, was one comment, with the following admission: "But leadership comes out of strong-minded people and I don't think the minerals industry has been blessed with too many of those, certainly not long-term thinkers". Among the leadership problems identified was a lack of ability to communicate with labour, government, and the community in general.

Specific communication problems were discussed. The production goals at the mine level, for example, are at times different from overall or long-term corporate goals. Decision making was seen to be another part of the communication problem of management. A few participants stressed the importance of pushing decision making out of the head office down to the lower levels of management, closer to actual production. This helps companies cope with a rapidly changing world by allowing neded decisions to be made rapidly.

One Australian mining company was cited as offering a positive example in this regard. It has spent seven years looking for a structure that makes people want to work together, rather than against each other, and has made significant changes in the way the company was run. For example, head office staff has been reduced drastically and relieved of practical day-to-day decisions. The most important thing, it was stressed, is that a company's executives have to be willing to admit when it is being badly managed.

Inter-industry communication was also discussed, including the role of international study groups, which are seen to be useful means of communication. The question arose as to whether they are in fact the most useful forum, and one participant suggested that, since most of those participating in such groups are members of governments, they are not the people who know most about the industry's needs. Another participant disagreed, arguing that all the group members are well informed and do know what is going on in the industry. Nonetheless, even if serious problems are addressed by such groups, everyone agreed they cannot provide the leadership needed to take positive steps to resolve problems such as overcapacity and lack of product development.

The question of management commitment arose throughout the discussions. One area already mentioned is commitment to the development of new ideas, and another discussion focused on the proper use of human resources. Industry personnel must be recognized as a source of new ideas; the challenge is to provide the right environment to draw them out. The need for flexibility was also expressed, raising another challenge for industry: large companies need to develop the capability to respond and to be flexible in these rapidly changing times, in order to take advantage of new ideas when they arise.

One representative of a major firm felt that we are prisoners of our own culture, due to the adversarial relationship with unions that exists here. We cannot, he said, react to change as quickly as Japan, for example, even though Japanese industry must also deal with strong unions. One business expert disagreed with this interpretation of Japan's successes. His opinion was that Japan gets its management strategy from the West, and western industry has much to learn from the way this eastern country has incorporated our own strategies. The West, agreed another participant, has its own winners, but it does not study its own success stories. We should be looking at Marks and Spencer in the U.K. or Herman Miller in the USA, for example, and trying to emulate them.

The mineral industry, however, does not even have to look outside its own boundaries for examples of good management. This seminar's focus on metals, pointed out one government representative, ignores industrial and structural minerals, which as a group are now greater than metals in terms of value of production. Since the products of this mineral group generally are not recyclable, their share of production value will continue to grow. One lesson the industrial and structural minerals group can teach the metals industry, stated the participant, is how to deal with overvalability. Given the abundance of limestone, for example, the industry has concentrated on higher quality deposits and improvement of transportation access and facilities (e.g. bigger tankers, deeper ports), and on aggressive marketing.

The Role of Government and of Exchange Rates in Profitability

"And where does government fit in in a very competitive world, besides lowering taxes?" asked a government representative. The answer from one industry executive was that the question is not one of lowering taxes, but of a better method of taxation: for example, one that differentiates between a depleting resource base and a non-depleting one. Other suggestions included some kind of tax break for risk takers, and a possible role for government in establishing infrastructure for new mining areas, especially in the case of marginal orebodies (which again raises the question of subsidies). One problem, felt a participant, is that government dollars tend to go where things are going well (i.e. targeting winners), but not where the need is greatest because things are going badly. The Northwest Territories Chamber of Mines, for example, has a budget of only $120,000 per year to deal with all of the issues of all its mining clients.

In terms of marketing, the role for government was seen to be one of a catalyst, to encourage the industry to do more in this lay area.

As for exchange rate problems, although no solutions were offered, their influence on the industry is clearly evident. In regards to the situation in Canada, Norman Keevil stated in his paper: "if the Canadian dollar is allowed to reach parity with the U.S. dollar in the 1990s, we can say good-bye to most of our minerals industry". The only way we could compete if the dollar reaches parity with the U.S. dollar, it was suggested, would be to cut our labour costs by a third, in real dollars, and reduce government taxes. Industry spokesmen noted that all of their productivity gains in recent years can be wiped out by a rise of a few cents in the Canadian dollar. The problem seems inescapable, since rising prices for natural resources generally lead to strengthening currency in the resource-producing countries.

Trade Issues

Not surprisingly, the Canada/U.S. trade negotiations were of considerable interest, not only to North Americans but also to Australians. Australia, it was noted, fearing that it may be shut out of U.S. markets, considers the prospect of a Canada-U.S. free trade agreement with apprehension. While the Canadian mineral industry strongly favours free trade in principle, related uncertainties in need of further study and appropriate early response include the potential effects of exchange rate fluctuations, and the quality of the response that can be expected from Canadian producers in the face of opportunities offered by free trade.

One challenge provided by free trade is that Canada will be forced to discipline its costs. This imposed discipline is something Canada needs to face global competition in the "real world". As a result, Canadians may find and develop the ability to be very competitive. Free trade may also offer in the longer term an influx of exploration dollars for minerals such as base metals as well as strategic and rare minerals.

On the negative side, one participant feared that the uranium processing industry might suffer under free trade. Another answered, however, that even in a worst-case scenario, the USA would not be able to produce all the uranium required for its own market. Another concern voiced was for downstream processes and fabricating of metals, given the smaller scale of Canadian plants in comparison to those in the USA.

One view was that free trade should have a fairly minor impact on mineral producers in Canada, since most mineral trading is already carried out without tariff barriers. What is needed, however, is protection against non-tariff barriers such as the protectionist moves instigated by U.S. producers.

The question of U.S. protectionist policies raised some frustrations felt in the industry. One observation made was that the USA considers the Canadian mining industry as being heavily subsidized, at times viewing important social policies, such as efforts to control acid rain, or regional development initiatives, as subsidies. Another observation was that trade restrictions in the USA, such as the softwood lumber and ground-fish actions, unleash tremendous problems in Canada. This situation John Cordes viewed as regrettable but not unfair. As he stated in his paper: "Both countries maintain their share of protectionist devices. That U.S. actions may injure Canadian interests more than similar Canadian actions would harm U.S. interests is a fact of size, not of legitimacy."

Whatever the national point of view adopted, questions of definition and measurement of subsidies are in urgent need of resolution, and the issues around growing protectionism must be faced within the new trading environment created by free trade and other arrangements such as GATT.

Health and Safety

Health and safety concerns apply to many of the issues discussed throughout the seminar. Products marketed must conform to EPA standards; industry must devote some of its R&D effort to possible health hazards of the substances it produces or of the processes and methods it uses. For example, nickel has been declared a hazardous substance in the U.S. because of links to certain types of cancer. This move could limit uses for nickel, and also raises costs due to strict labelling and other regulations.

Particular concerns revolved around responsibility issues. Where, for example, does responsibility lie for regulation and for ensuring safe practices? And who pays for the escalating liability costs? In their answers to these and other questions, participants offered some suggestions to industry and to government on how to fund health and safety costs. They also indicated that the mineral industry has reason for concern when it comes to health and safety costs that may arise in the future as a result of past activities.

Responsibility for Regulation

Both government and industry are interested in the regulation of safe practices. The present situation, however, involves governments as the formulators of regulations, with industry adhering to the regulations - regulations that industry views at times as not compatible with many of its complexities. One participant wondered if it would be realistic to decouple government regulation from health and safety regulation and leave science to define needs and responses.

Participants agreed that more government/industry teamwork, including labour unions, is needed in this area. Problems were seen to arise when government regulation fails to take industry realities and practicality into account, and from the industry side when companies must be forced to conform to regulations rather than actively seeking to promote health and safety measures. Another perceived problem was that the activities being regulated are not always legitimate issues, and simply divert a company's efforts away from its own particular health and safety concerns.

The role of unions in regulating health and safety was also discussed at length. In Canada, an increasing number of provinces require health and safety committees made up of both management and workers. The new Ontario Occupational Health and Safety legislation, for example, is giving such committees more power. This, however, does not solve the problem presented by one participant, where unions often see health and safety as a way to increase their own power and turn it into an area for confrontation. By placing another barrier between management and employees this development has a negative effect on communications and the rate at which change can be implemented in the workplace.

Cooperation between management and employees and their unions was seen as a prerequisite to setting up adequate health and safety procedures. Unfortunately, the perception that, historically, companies have not been concerned by health and safety problems is in many cases founded in reality, and is hard to shake. "Industry has shown unwillingness in the past to act on knowledge of health and safety dangers, and has to overcome (and pay for) past deliberate actions and mistakes", was one view presented.

Liability

Society, it was noted, has not yet decided where responsibility lies for health and safety problems, or who should carry the costs - the consumer, taxpayer, victim, producer? This is a great concern, given the enormous potential costs for compensation to employees for past and present industrial practices which are only identified as hazardous after-the-fact, and which are being left to the future to be paid.

Participants agreed that employers have total direct responsibility to employees as far as their knowledge of safe practices permits, but that it would be unfair to make individual companies pay fully for unanticipated consequences of existing practices. If companies now in operation are forced to pay for all accumulated past problems (i.e. for current or future costs resulting from past acceptable practices), then their survival may be endangered.

Another problem in the area of liability for worker health and safety is the increasing proportion of employees submitting compensation claims, due in part to an ageing workforce. In addition, it is believed claims are being filed that are related to employee lifestyle rather than working conditions. Compensation claims may be related to personal habits, such as smoking or drinking, or to leisure-time injuries.

Yet another serious problem was noted regarding liability: where in the past, the employees' right to sue was traded for compensation, now this right has been regained, at the same time that compensation liability of the employer is being expanded.

Suggested Actions

Regulation:

Participants strongly agreed that the drawing up of health and safety regulations and their enforcement must be a joint management/worker task. Inco, for example, uses worker-inspectors trained in health and safety who are paid by the company but hired by the union. In response to a comment that this reinforces the adversarial view that the union forces health and safety on a reluctant management, one participant noted that the system works well, even though it does not eliminate the tendency for adversarial positions between the two groups.

Liability:

Participants suggested that, for the future, a no-fault fund might be a good approach. However, the incentive to be a good corporate citizen would disappear, unless regulations and enforcement were in place to prevent poor corporate citizens from abusing such a scheme.

For past and present costs, the question of liability was identified as one in need of serious study. A Quebec solution was presented, where liability is decided by a neutral third party. This approach, however, worries the industry since it pays all the bills but has no control over the decisions. One participant suggested that the only way to reduce the number and amount of claims was to have the worker pay a share.

Safe Working Practices:

Prevention was seen as the best solution. Many companies have successfully used health and safety awareness and training initiatives to cut injuries and worker compensation costs. But before expanding such programs, explained a participant, a cost-benefit study is needed.

As a more general, day-to-day suggestion, a mining manager stated that both management and workers should be sensitive to the fact that mental lapses due to personal stress can be the cause of accidents on the job, and anticipate problems. For example, heavy equipment operators should be able to approach management and ask for a temporary change of job if they feel they are too sleepy or otherwise incapacitated to perform with complete safety. Although employees should be expected to give top priority to their own safety and that of their co-workers, this is not always the case, due to macho attitudes, production bonuses, complacency, or carelessness.

Environmental Concerns

Participants warned that Canadian mineral producers are facing a "time bomb" in the field of the environment that will have to be dealt with in the near future: unfunded reclamation requirements for old or former mineral production facilities. As with the problem of unfunded liability for illnesses now being identified as related to past work experience and exposure, the timing and the extent of the reclamation problem is still unknown, but the financial implications are significant, to say the least - as are its effects on the public image of the industry.

Although the land area affected by mining does not compare, for example, to that taken up by highways, or its pollution to that caused by municipalities, mining is often singled out for attack by environmentalists. This is more than just an image problem, noted one participant, who pointed out that as a result of the new Canadian Environmental Protection Act criminal charges and jail terms for senior executives of companies charged with pollution are now a distinct possibility. In fact, it appears easier to win a case against an individual rather than a company, in such circumstances.

As an alternative to after-the-fact punishment, one suggestion was a contractual approach to costs of keeping the environment clean. However, there was also opposition to the principle of allowing companies to pay for the right to pollute.

Participants agreed that industry is responsible for the problems it has knowingly created. Unfortunately, in some cases steps taken in past years in good faith are now turning out to be long-term problems, with associated unanticipated costs. The responsibility for liability is uncertain in such instances.

Conclusion: Need for Industry Leadership

A major concern of participants throughout the discussions was the lack of leadership emerging from the mining industry with regard to these issues, not just in Canada but worldwide. For the situation to improve, some country, organization, group, or individual, must be willing to take responsibility, for example, for leading the mineral industry away from overcapacity and severely fluctuating market conditions. The mineral industry of the '90s must become more proactive and devote more resources to developing its own markets, and in responding to the threat from new materials. Executives in the industry must also take a leadership role in improving its image - both in the eyes of the public and in the eyes of its own employees.

In areas of the environment and health and safety, industry also has an opportunity to exercise a proactive and constructive leadership role - for example, by working on alternative models for regulatory systems; or by generating initiatives in reclamation techniques, pollution control, recycling, quality of working environment, and compensation equity. Spending on such initiatives will serve the industry in two ways. First, they will cut costs in the long term and possibly generate new economic activities. Second, they will generate goodwill to counteract a predicted decline in relative economic and therefore political clout. This goodwill will be useful in attempting to maintain better political and economic environments for facing an uncertain future.

"It must be very difficult to look 15 months ahead when shareholders are asking about last quarter results," stated a participant. But looking ahead is what the minerals industry must do, not just for 15 months, but for years and even decades. The industry, concluded workshop participants, must not only look ahead, but also take a more active role in determining its future directions, or it may find itself out of business in the long run.

APPENDIX I PROGRAM OF THE SEMINAR

18th CRS POLICY DISCUSSION SEMINAR
PROSPECTS FOR MINERALS IN THE '90s

Wednesday, October 14

8:00 p.m.	Keynote Address: **Future Challenges Facing the Canadian Minerals Industry: A Private Sector View** Norman Keevil, President and Chief Executive Officer, Teck Corporation

Thursday, October 15

8:30 a.m.	**Emerging Trends in World Mineral Competition** John McLeod, Vice President and Group Economist, CRA Limited
10:15 a.m.	**Emerging Issues in Mineral Trade** John Cordes, Professor and Head, Department of Mineral Economics, Colorado School of Mines
1:00 p.m.	**World Supply - Demand Patterns in the 1990s** Simon Hunt, Director, Brooke-Hunt Associates
2:45 p.m.	**Prospects for Canadian Mineral Endowment** Jan Zwartendyk, Director, Resource Evaluation Division, Energy, Mines and Resources Canada
4:00 p.m.	Plenary session

8:00 p.m.	**Canada's Future Position as a Mineral Producer: Government Perspectives** Pierre Perron, Associate Deputy Minister, Energy, Mines and Resources Canada
Friday, October 16	
8:30 a.m.	**Emerging Competition: The New Materials** Peter McGeer, Director, R&D Division, Alcan International Ltd., Kingston
10:00 a.m.	**Quality of Working Life: The Challenge of Occupational Health and Safety** Beverly Harris, President, Occupational Health Nurses Association, and Dr. Albert Cecutti, Chairman, Occupational Health Committee, Ontario Medical Association
1:30 p.m.	Small group discussions on major issues
2:30 p.m.	Concluding plenary session

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Simon Hunt has a long association with the mineral industry, including employment with Rhodesia Selection Trust in Africa and with the Anglo American Corporation. In 1975 he founded Brook Hunt and Associates, an independent research company based in London, England, which concentrates on metal and mineral resources and markets.

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John Macleod, a graduate of the University of Western Australia, is currently Vice President and Group Economist for CRA Limited, an international resources group based in Melbourne with mining, refining, smelting and marketing interests. Mr. Macleod has worked as an economist and banker in New Zealand, the United Kingdom, and the United States as well as in Australia. His business experience has been in banking (Australia and New Zealand Bank), investment banking (Citinational and Barclays) and resources (CRA). In addition, he is Director of Wimmera Industrial Minerals, a CRA subsidiary company, President of the Central Council of the Economic Society of Australia (the second business economist to hold this position since the Society was formed in 1924), and a member of numerous advisory councils and committees.

J. Peter McGeer, who holds degrees in chemistry from Princeton (PhD, MSc) and the University of British Columbia (BA, MA), is Managing Director of the Ontario Centre for Materials Research, one of the Centres of Excellence established by the Government of Ontario. He was appointed to this position after retiring as Director of Alcan International's Kingston Research and Development Centre, having served 38 years with that corporation. At the time of this discussion seminar, Dr. McGeer was Chairman of the Board of both the Canadian University Industry Council on Advanced Ceramics (CUICAC) and the Canadian Advanced Industrial Materials Forum (CAIMAF). He continues to serve as Vice-Chairman of the Board of the Welding Institute of Canada and is active in a number of other technical organizations.

Pierre Perron is a graduate of the Royal College of Science and Technology, University of Strathclyde, Glasgow (PhD in metallurgy) and of Universite Lavel (science and BaASc in metallurgical engineering). After working at AECL's Chalk River Laboratores on R&D related to materials and nuclear fuels, Dr. Perron joined Hydro Quebec as manager of the Radiation-Protection Department. He was next appointed Director of Materials Science at the Centre de recherche industrielle du Quebec (CRIQ) and in 1975 became the Centre's Director of Research and Development. Seven years later he was invited to become Associate Deputy Minister (Mines) of the Ministry of Energy and Resources of Quebec. Dr. Perron is now Associate Deputy Minister, Energy Mines and Resources Canada.

Jan Zwartendyk graduated from the Pennyslvania State University (PhD in mineral economics) and McGill University (MSc in geology) after studying mining engineering and geology in Holland. He worked as an exploration geologist in the Canadian oil industry for a decade, and was briefly associated with Resources for the Future, Inc. in Washington, D.C. As a division head in the Department of Energy, Mines and Resources in Ottawa, Dr. Zwartendyk is now concerned with various aspects of mineral resource evaluation. He has been particularly interested in combining the different perspectives of geologists, engineers and economists in the field of mineral resources and in promoting a better understanding of the connections between mineral resources and supply.

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